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NUMERICAL ANALYSIS OF STIFFENED SHELLS OF REVOLUTION

Volume V of VII

by V. Svalbonas and P. Ogilvie

Prepared by
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16. ABSTRACT

This manual contains engineering programming information for the STARS-2B (Shell Theory Automated for Rotational Structures -2B (Buckling)) digital computer program. The report is written for the engineer who will need to make small alterations to the program, such as incorporating a new geometry, or altering a table size, to fit his specific needs. The sections of the manual each cover one major subroutine. These sections are further subdivided in the following manner where applicable:

A. Subroutine description.

B. A list of pertinent engineering symbols and their FORTRAN coded counterparts.

C. Subroutine flow chart.

D. Subroutine FORTRAN listing.

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VOLUME II. Users' Manual for STARS-2S - Shell Theory Automated for Rotational Structures - 2 (Statics), Digital Computer Program

VOLUME III. Users' Manual for STARS-2B, 2V - Shell Theory Automated for Rotational Structures - 2 (Buckling, Vibrations), Digital Computer Programs

VOLUME IV. Engineer's Program Manual for STARS-2S - Shell Theory Automated for Rotational Structures - 2 (Statics), Digital Computer Program

VOLUME V. Engineer's Program Manual for STARS-2B - Shell Theory Automated for Rotational Structures -2 (Buckling), Digital Computer Program

VOLUME VI. Engineer's Program Manual for STARS-2V - Shell Theory Automated for Rotational Structures -2 (Vibration), Digital Computer Program

VOLUME VII. Satellite Programs for the STARS System

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INTRODUCTION

This manual presents a general description of the STARS-2B digital computer program. FORTRAN IV is used exclusively in writing the various subroutines. The execution of this program requires the use of eleven temporary storage units.

The program was initially written and debugged on the IBM 370-165 computer and then converted to the UNIVAC 1108 computer, where it utilizes approximately 46,000 words of core. Only basic FORTRAN Library routines are required by the program, these being: sine, cosine, absolute value, square root, min 0, max 0, amax 1, amin 1, and random.

For ease and speed in usage, the Table of Contents on the following page has also been laid out to present the call sequence of the program.

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SUBROUTINE MAIN

MAIN is the control link for the entire program. Sizing values are read into the program, as well as information for eigenvalue or determinant accuracy calculations, and the material property tables. Calls are made to subroutines RIEMAN and SEGMAT once for each segment in a region; then subroutine REGMAT is called. This procedure is executed once for every region in the structure. Finally a call to subroutine STRMAT is made. If the clues are set for the program to calculate the prestress state, subroutines INITAL and LEBEGE are called. Otherwise the control link loops back and resets the clues for the calculation of nonlinear stiffness matrices.

In the calculation loop for the nonlinear stiffness matrices the program proceeds as above to STRMAT. Next EIGVAL or DETERM are called to calculate eigenvalues or evaluate a determinant as per user input. If these calculations satisfy convergence criteria, subroutines BCVECT, INITAL, and LEBEGE are called. If convegence criteria are not satisfied the program will loop until satisfaction is obtained.

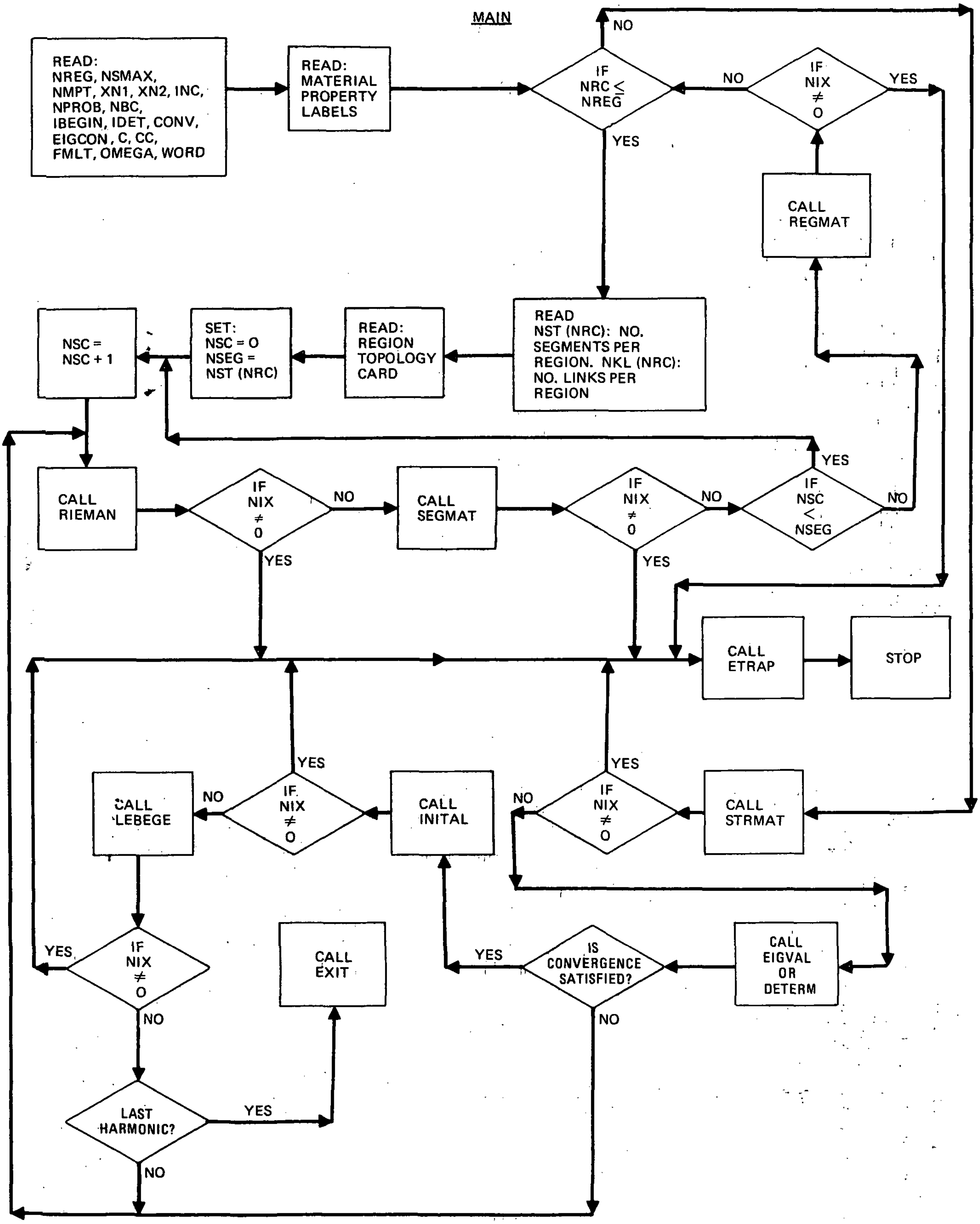
In a multi-harmonic eigenvalue search the whole procedure loops on the harmonic number.

There are also several counters in this control link. These are defined as follows:

- NSC - Counts the calls to subroutines RIEMAN and SEGMAT, from 1 to the number of segments within a region.
- NRC - Counts the calls to subroutine REGMAT, from 1 to the number of regions in the structure.
- ICYC - Cycle counter (counts harmonics).
- NPASS - Pass counter (counts passes necessary to converge in a single harmonic).

The block data and overlay listings are included in this section.

MAIN


READ: NREG, NSMAX, NMPT, XN1, XN2, INC, NPROB, NBC, IBEGIN, IDET, CONV, EIGCON, C, CC, FMLT, OMEGA, WORD
READ: MATERIAL PROPERTY LABELS
IF NRC ≤ NREG
NO
YES
IF NIX ≠ 0
CALL REGMAT
READ NST (NRC): NO. SEGMENTS PER REGION. NKL (NRC): NO. LINKS PER REGION
READ: REGION TOPOLOGY CARD
SET: NSC = 0 NSEG = NST (NRC)
NSC = NSC + 1
CALL RIEMAN
CALL SEGMAT
IF NSC < NSEG
CALL ETRAP
STOP
CALL LEBEGE
CALL INITAL
CALL STRMAT
LAST HARMONIC?
CALL EXIT
IS CONVERGENCE SATISFIED?
CALL EIGVAL OR DETERM

```
C ..... RØUTINE **D1       ** ABACUS UPDATED 07/01/72 .....
      BLØCK DATA
      CØMMØN /NAM1/ FACE(4),STRGØ(7),THERM(4),MATER(3),SEGTAB(12)
      DATA STRGØ /11.0,13.0,21.0,31.0,12.0,14.0,15.0/
      DATA THERM /4HTHST,4HNØTH,4HTHCN,4HTHIN/
      DATA MATER /4HISØT,4HØRTH,4HSTIF/
      DATA SEGTAB/4HST10,4HTHIC,4HRWAF,4HRWA1,4HRWA2,4HRWA3,4HISG1,
     1            4HISG2,4HISG3,4HST11,4HST12,4HST13/
      DATA FACE /4HSING,4HEQUA,4HUNEQ,4HBLAN/
      CØMMØN /WINTER/INDIC8
      CØMMØN /BØND/M,L
       END
```

```
C ..... RØUTINE **D2       ** ABACUS UPDATED 07/25/72 .....           200000
      INTEGER SAVJTC,SAVSTP,SEGTAB, Q ,THICK,TYPE                         200010
      INTEGER XN1,XN2,XN                                                  200020
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK                   200030
      DØUBLE PRECISIØN YCØRR                                              200040
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)          200050
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)                              200060
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(2),NH             200070
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)   200080
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB  200090
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE  200100
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS             200110
      CØMMØN /NAM1/ FACE(4),STRGØ(7),THERM(4),MATER(3),SEGTAB(12)        200120
      CØMMØN /LYCØRR/ YCØRR(80)                                           200130
      CØMMØN /ARING/ NRING(28),AMAT(30,4),IRLC(28)                        200140
      DIMENSIØN QVEC(128,2)
    1 WRITE(6,1726)                                                       200200
 1726 FØRMAT(1H1)                                                         200210
      REWIND 1                                                            200220
      REWIND 2                                                            200230
      REWIND 3                                                            200240
      REWIND 4                                                            200250
      REWIND 8                                                            200260
      REWIND 9                                                            200270
      REWIND 10                                                           200280
      REWIND 11                                                           200281
      REWIND 12                                                           200300
      REWIND 13                                                           200310
      REWIND 14                                                           200320
      NIX = 0                                                             200330
      Q=5                                                                 200340
      READ(5,1001,END=555) (STØRY(I),I=1,16)                              200360
 1001 FØRMAT  (16A4)                                                      200370
      READ(5,1002) NREG,NSMAX,NMPT,XN1,XN2,INC,NPRØB,NBC,KBC,IBEGIN,     200380
     1             IDET,CØNV,EIGCØN,C,CC                                  200380
 1002 FØRMAT(I2,I3,9I2,4F7.0)                                             200390
      XN = XN1                                                            200410
      WRITE(6,602) NSMAX,NREG,NMPT,NPRØB,NBC,XN1,XN2,INC                  200420
  602 FØRMAT(////19X,93HUNSYMMETRIC, ØRTHØTRØPIC, REINFØRCED SHELL ANALY 200430
     1SIS WITH CØUPLING ØF AT MØST 29 SHELL REGIØNS//62X,-STARS-2B-//    200440
     2 56X,-AS ØF NØVEMBER 1, 1972-////8X,21HNUMBER ØF SEGMENTS = ,I3,   200440
     321H NUMBER ØF REGIØNS = ,I2,43H NUMBER ØF MATERIAL PRØPERTY TABLES 200460
     4 USED = ,I2,22H NUMBER ØF PRØBLEMS = ,I2//8X,-NUMBER ØF BØUNDARY C 200470
     5ØNDITIØN MATRICES = -,I2////40X,-STABILITY HARMØNICS (N) = -,I2,   200480
     6 - TØ -,I2,- INCREMENTED BY -,I2)                                   200490
      IF (KBC.NE.0) GØ TØ 502                                             200500
      WRITE(6,604)                                                        200510
  604 FØRMAT(///31X,-THE GIVEN INPUT INDICATES THAT THE PREBUCKLING STAT 200520
     1E WILL BE CALCULATED-)                                              200530
      GØ TØ 503                                                           200540
  502 WRITE(6,608)                                                        200550
  608 FØRMAT(///31X,-THE GIVEN INPUT INDICATES THAT THE PREBUCKLING STAT 200560
     1E WILL BE PRØVIDED-)                                                200570
  503 CØNTINUE                                                            200580
      WRITE(6,605)  (STØRY(I),I=1,16)                                     200590
  605 FØRMAT(8(/),8X,16A4,18(/),80X,35HFØR INFØRMATIØN CALL   V. SVALBØN 200600
     1AS/117X,14H(516) 575-7701/103X,10HP. ØGILVIE)                       200610
      IF (CØNV.EQ.0.0) CØNV = 0.01                                        200620
      CØNVER = CØNV
      IF (C.EQ.0.0) C = 0.05
```

```
      IF (CC.EQ.0.0) CC = 1.0
      D = CC*C
      F = C
      MDET = 0
      KDET = 0
      XNL(1) = 0.0                                                      200630
      XNL(2) = 0.0                                                      200640
      NLCASE = NPRØB                                                    200650
      NH = 0                                                            200660
      XN = 0                                                            200670
      ICYC = 1                                                          200680
      NPASS = 0                                                         200690
      NPAS = 0                                                          200700
      KNBC = 2                                                          200710
      LINPUT = 1                                                        200720
      JNBC = IABS(NBC)                                                  200730
      EIGCØN = ABS (EIGCØN)                                             200711
      NRØW=0                                                            200740
      KK=-1                                                             200750
      NSAVE=0                                                           200760
      DØ 13 I=1,NMPT                                                    200770
      KK=KK+2                                                           200780
      NXMAT(KK)=NRØW+1                                                  200790
      II=NRØW+1                                                         200800
      READ(5,1004) STD(I),TYPE                                          200810
 1004 FØRMAT (A4,6X,A4,6X)                                              200820
      NRØW = 11                                                         200830
      DØ 11 L=1,3                                                       200840
   11 IF(TYPE.EQ.MATER(L)) GØTØ 12                                      200850
      GØ TØ 8000                                                        200860
   12 CØNTINUE                                                          200870
      IF(L.EQ.1) NRØW=4                                                 200880
      IF(L.EQ.2) NRØW=7                                                 200890
       LLL=NSAVE+NRØW                                                   200900
      READ (5,1005) ((XMAT(M,J),J=1,10),M=II,LLL )                      200910
 1005 FØRMAT (5E14.7)                                                   200920
      NRØW=NSAVE+NRØW                                                   200930
      NXMAT(KK+1)=LLL                                                   200940
   13 NSAVE=NRØW                                                        200950
      READ(5,2000)                                                      200960
 2000 FØRMAT(1X)                                                        200970
  100 NPASS = NPASS+1                                                   200980
      REWIND 13                                                         201070
      REWIND 4                                                          201080
      IF (KBC.NE.0) NPRØB = 0                                           201090
      IF (NH.EQ.0) GØ TØ 618                                            201100
      IF (ICYC.GT.1.AND.NPASS.EQ.1) GØ TØ 618                           201110
      IF (NPASS.LT.3.AND.XN.EQ.XN1.AND.(XN.NE.0.ØR.NLCASE.NE.1))        201120
     1    GØ TØ 618                                                     201130
      NPAS = NPAS+1                                                     201140
      WRITE(6,1726)                                                     201160
      WRITE(6,607) XN                                                   201170
      WRITE(6,611) NPAS
  618 REWIND 10                                                         201160
      DØ 99 NRC=1,NREG                                                  201161
      IF (NH.EQ.0.ØR.IBEGIN.EQ.1) WRITE(6,1726)                         201200
      IF (Q.EQ.5) READ(5,1003) NST(NRC),NKL(NRC),NRING(NRC),STØRY       201210
 1003 FØRMAT(3I2,16A4)                                                  201220
      IF (NH.NE.0) GØ TØ 613                                            201230
      WRITE(6,606)NRC,NST(NRC),NKL(NRC)                                 201240
  606 FØRMAT(/////////////////////////58X,13HREGIØN NUMBER,I3//35X,10HTH 201250
```

```
      1ERE ARE ,I2,14H SEGMENTS AND ,I2,35H KINEMATIC LINKS WITHIN THIS R  201260
     2EGIØN)                                                              201270
      GØ TØ 610                                                           201280
  613 IF (IBEGIN.EQ.0) GØ TØ 610                                          201290
      WRITE(6,612) NRC,NST(NRC),NKL(NRC)                                  201300
  612 FØRMAT(///58X,13HREGIØN NUMBER,I3//35X,10HTHERE ARE ,I2,14H SEGMEN  201310
     1TS AND ,I2,35H KINEMATIC LINKS WITHIN THIS REGIØN)                  201320
      WRITE(6,607) XN                                                     201330
  607 FØRMAT(/57X,-HARMØNIC (N) =-,I3)                                    201340
      IF (NPAS.NE.0) WRITE(6,611) NPAS                                    201350
  611 FØRMAT(/61X,-ESTIMATE-,I3)                                          201360
  610 CØNTINUE                                                            201370
      IF (Q.EQ.5) READ(5,1006) JRTIC(NRC),JRSTØP(NRC),STØRY               201380
 1006 FØRMAT(5X,2I5,16A4)                                                 201390
      NSEG = NST(NRC)                                                     201400
  201 NSC=0                                                               201410
  101 NSC=NSC+1                                                           201420
      IF (NH.EQ.0.ØR.IBEGIN.EQ.1) WRITE(6,1726)                           201430
      CALL RIEMAN                                                         201440
      IF (NIX.NE.0) GØTØ 8888                                             201450
      CALL SEGMAT                                                         201460
      IF (NIX.NE.0) GØTØ 8888                                             201470
      IF(NSC.LT.NSEG) GØ TØ 101                                           201480
      NSC= 0                                                              201490
  102 CALL REGMAT                                                         201500
      IF(NIX.LT.0) GØ TØ 8888                                             201510
      NIX = 0                                                             201520
       REWIND 2                                                           201530
       REWIND 3                                                           201540
   99 CØNTINUE                                                            201550
      REWIND 11                                                           201521
      CALL STRMAT                                                         201570
      IF (NIX.NE.0) GØTØ 8888                                             201580
      IF (NH.EQ.0) GØ TØ 200                                              201590
      IF (NPASS-2) 71,72,198                                              201600
   72 LINPUT = 0                                                          201610
      IF (XN.NE.XN1) GØ TØ 198                                            201620
      IF (XN.EQ.0.AND.NLCASE.EQ.1) GØ TØ 198                              201630
   71 XNL(NLCASE) = 1                                                     201640
      LINPUT = 0                                                          201650
      REWIND 1                                                            201660
      GØ TØ 100                                                           201670
  198 IF (IDET.EQ.1.AND.NPAS.GT.1) GØ TØ 707                              201680
  520 CALL EIGVAL (CØNVER,EIG,NZ,IBEGIN,QVEC)                             201681
      IF (NPAS.EQ.1) GØ TØ 710                                            201690
      A = XNL(NLCASE)*(2.0*EIG+1.0)/3.0                                   201700
      IF (ABS(ABS(EIG)-1.0).LE.CØNVER) A = XNL(NLCASE)*EIG                201701
      IF (ABS(ABS(EIG)-1.0).LE.CØNVER.AND.IDET.EQ.1) GØ TØ 711            201702
      XNL(NLCASE) = A                                                     201703
      GØ TØ 711                                                           201710
  710 XNL(NLCASE) = EIG                                                   201720
      KFLAG = XNL(NLCASE)/ABS(XNL(NLCASE))
      GØ TØ 711
  707 CALL DETERM (NZ,MDET)
      IF (MDET.EQ.KDET.ØR.KDET.EQ.0) GØ TØ 709
      XNL(NLCASE) = XNL(NLCASE)/(1.0-KFLAG*F)
      IF (F.GT.D) GØ TØ 521
      CØNVER = 1.E8
      GØ TØ 520
  521 F = F*0.1
      MDET = -MDET
```

```
  709 XNL(NLCASE) = (1.0-KFLAG*F)*XNL(NLCASE)
      KDET = MDET
  711 CØNTINUE                                                          201730
      WRITE(6,700) XNL(NLCASE)                                          201740
  700 FØRMAT(//5X,-THE CURRENT LØAD MULTIPLICATIØN FACTØR =-,1PE14.6)   201750
      IF (ABS(XNL(NLCASE)).LT.EIGCØN.ØR.EIGCØN.EQ.0.0) GØ TØ 510
      WRITE(6,511)
  511 FØRMAT(/  4X,-EIGENVALUE UPPER LIMIT EXCEEDED IN THIS HARMØNIC.-/)
      GØ TØ 500
  510 CØNTINUE
      IF (ABS(ABS(EIG)-1.0).LE.CØNVER) GØ TØ 199                        201810
      REWIND 1                                                          201770
      GØ TØ 100                                                         201780
  199 NPRØB=2
      CALL BCVECT (NZ,QVEC,NØJS,JRTIC,JRSTØP,NREG)                      201800
  200 CØNTINUE                                                          201810
      IF (KBC.NE.0.AND.NH.EQ.0) GØ TØ 500                               201820
      CALL INITAL                                                       201830
      REWIND 15                                                         201791
      CALL LEBEGE                                                       201840
  500 CØNTINUE                                                          201850
      CØNVER = CØNV                                                     201911
      REWIND 1                                                          201860
      NPRØB = 0                                                         201870
      IF (NH.EQ.0) GØ TØ 55                                             201880
      ICYC = ICYC+1                                                     201890
      NPASS = 0                                                         201900
      NPAS = 0                                                          201910
      MDET = 0                                                          201971
      KDET = 0                                                          201972
      F = C                                                             201973
      KNBC = KNBC+1                                                     201920
      LINPUT = 0                                                        201930
      IF (KNBC.LE.JNBC) LINPUT = 1                                      201940
      XN=XN+INC
      IF (XN.GT.XN2) GØ TØ 1                                            201960
      XNL(NLCASE) = 0.0                                                 201970
      GØ TØ 100                                                         201980
   55 XNL(1)=1.0
      Q = 1                                                             202020
      NH = 1                                                            202040
      LINPUT = 0                                                        202050
      IF (NBC.LT.0) LINPUT = 1                                          202060
      IF(XN.NE.XN1.AND.NBC.GE.2.AND.KBC.EQ.0) LINPUT=1
      IF (LINPUT.EQ.0) JNBC = JNBC+1                                    202080
      XN=XN1
      IF(NLCASE.EQ.1.AND.XN.NE.0) XNL(1)=0.0
      GØ TØ 100                                                         202090
  555 CALL EXIT                                                         202100
 8000 IERRØR=8000                                                       202110
      NERRØR= 1                                                         202120
 8888 CØNTINUE
      CALL ETRAP                                                        202140
      STØP                                                              202150
       END                                                              202160
```

OVERLAY

```
SEG RØØT
IN NBF24$
IN MAIN,BLDATA
SEG RIE*,(RØØT)
IN RIEMAN,SETUP,RØBØT,GEØMET,PLINE,PLICØ
SEG DF1*,(RIE)
IN DIF1
SEG DF2*,(RIE)
IN DIFF2
SEG SGMAT*,(RØØT)
IN SEGMAT,SREVN2
SEG SWCH*,(RØØT)
IN SWITCH,TRIEQ,FUTILE
SEG RING*,(SWCH)
IN RINGER
SEG REG*,(RING)
IN REGMAT,CHASE
SEG STR*,(RING)
IN STRMAT,FLEX
SEG EIG*,(SWCH)
IN EIGVAL CØMPAK,EIGEN,DØTPRØ,SYMEIG,TFØRM,STURM,PREP,QSVEC,DAGGER,ANDD
SEG DET*,(SWCH)
IN DETFRM,DET2,DCØMP2,SUPER
SEG BCV*,(SWCH)
IN BCVECT
SEG INI*,(RØØT)
IN INITAL
SEG LEB*,(RØØT)
IN LEBEGE,FIXEM,TØBAR,TEMØEG,PLYNE,PLYCØ
SEG ØD1*,(LEB)
IN ØDE1
SEG ØD2*,(LEB)
IN ØDE2
SEG TRAP*,(RØØT)
IN ETRAP
```

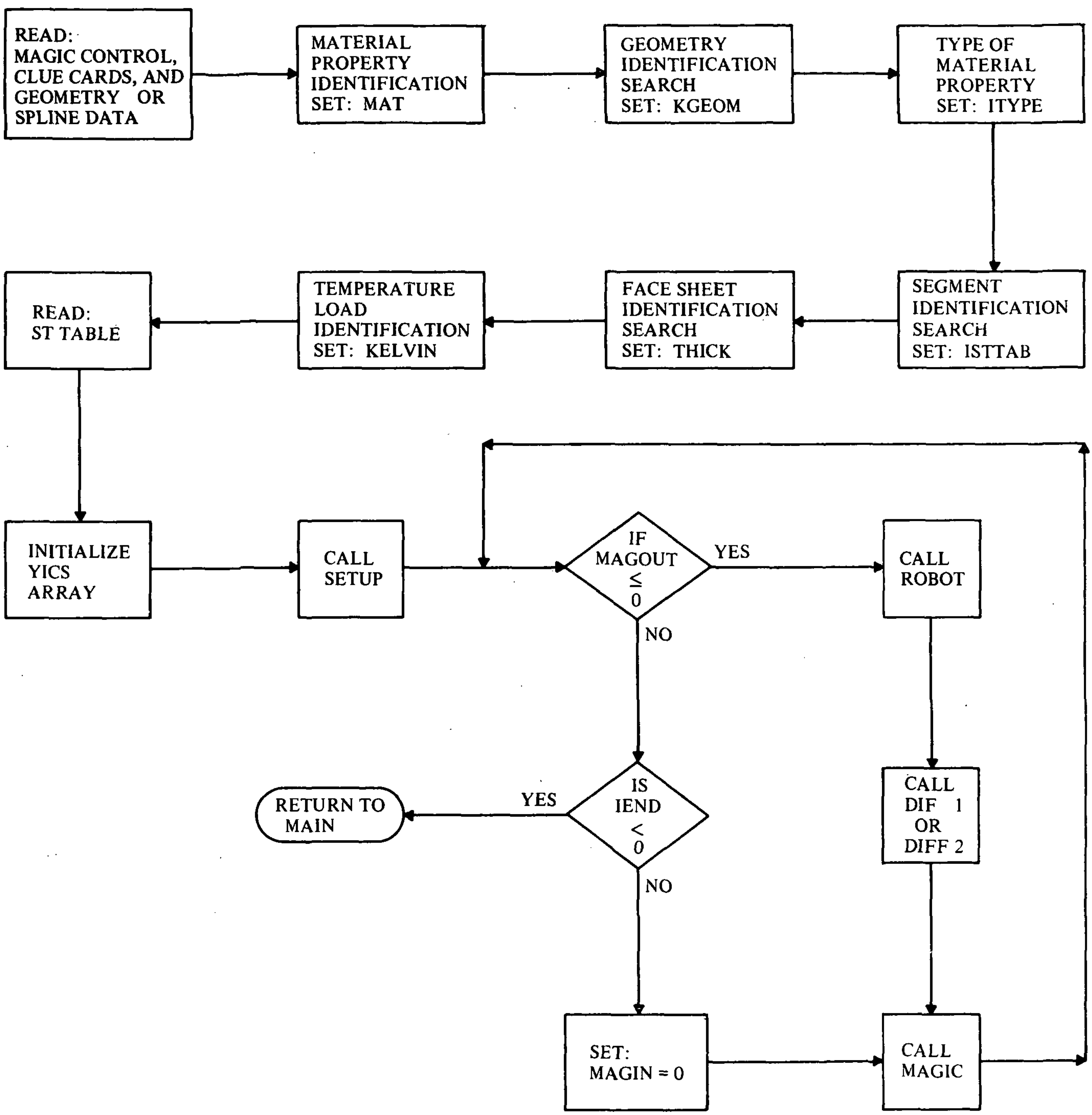
SUBROUTINE RIEMAN

This subroutine link assembles the data tables for use in the integration procedure. The program has the capability of handling 2 loading conditions (dead and live). Temperature load can be included in either one, but not both.

The subprogram link, RIEMAN, utilizes the subroutines SETUP, ROBOT, DIF1 or DIFF2, to integrate the differential equations of each segment independently, under arbitrary load conditions. The results of the integrations of each segment are stored in the YCORR array in RIEMAN, and represent the stiffness and deflection coefficients of each segment.

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1)
XFTHLD	f_{θ}
XFPHLD	f_{ϕ}
XFZELD	f_{ζ}
XMTHLD	m_{θ}
XMPHLD	m_{ϕ}
ETHET	E_{θ}
EPHI	E_{ϕ}
XGPT	$G_{\phi\theta}$
XNUTP	$\nu_{\theta\phi}$
XNUPT	$\nu_{\phi\theta}$
ALPHTH	α_{θ}
ALPHPH	α_{ϕ}
XNTTH	$N_{T\theta}$
XNTPH	$N_{T\phi}$
XMTTH	$M_{T\theta}$
XMTPH	$M_{T\phi}$
XK11	K_{11}
XK22	K_{22}
XD11	D_{11}
XD22	D_{22}
XK33	K_{33}
XD33	D_{33}

RIEMAN


READ:
MAGIC CONTROL,
CLUE CARDS, AND
GEOMETRY OR
SPLINE DATA
MATERIAL
PROPERTY
IDENTIFICATION
SET: MAT
GEOMETRY
IDENTIFICATION
SEARCH
SET: KGEOM
TYPE OF
MATERIAL
PROPERTY
SET: ITYPE
SEGMENT
IDENTIFICATION
SEARCH
SET: ISTTAB
FACE SHEET
IDENTIFICATION
SEARCH
SET: THICK
TEMPERATURE
LOAD
IDENTIFICATION
SET: KELVIN
READ:
ST TABLE
INITIALIZE
YICS
ARRAY
CALL
SETUP
IF
MAGOUT
≤
0
YES
NO
CALL
ROBOT
CALL
DIF 1
OR
DIFF 2
IS
IEND
<
0
YES
NO
RETURN TO
MAIN
SET:
MAGIN = 0
CALL
MAGIC

```
C ..... RØUTINE **D3        ** ABACUS UPDATED 07/24/72 .....             300000
      SUBRØUTINE RIEMAN                                                  300010
      SQRT(X) = DSQRT(X)                                                 300020
      INTEGER SAVJTC,SAVSTP,SEGTAB, Q ,THICK,TYPE                        300030
      INTEGER XN                                                         300040
      DØUBLE PRECISIØN  YNEW,YPRED                                       300050
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK                  300060
      DØUBLE PRECISIØN YCØRR                                             300070
      DØUBLE PRECISIØN ARG,ERR,DIFF,DTAU,STEP,TIME
      DØUBLE PRECISIØN DELTA,DTIME,EPSIL,XSAVE2,XSAVE3,XSAVE4
      DØUBLE PRECISIØN YDEV,YICS,TBDEL,FWDEL                             300110
      DØUBLE PRECISIØN YDØT,YASAVE,YANTH,YAMTH,YAMPT,YAJPH,S,SN,CS,SNSQ, 300120
     1                 CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,X1RØ,X1RØSQ,X1SNRØ,  300130
     2                 X1CSRØ,CN1RØ,SN1RØ,CS1RØ,X1R1,X1R2,CS1R1,CS1R2,   300140
     3                 SN1R1,X1R1SQ,R2SQ,RØ,BESQ,RØSQ,XNSQ,R1,R2,S1,     300150
     4                 R1DØT,XNTTH,XNTPH,XMTTH,XMTPH,XC11,XC22,XC15,     300160
     5                 XD33,XD22,XD21,XD12,XK11,XK12,XK21,XK22,XK33,     300170
     6                 XD11,XNPHI,BETA,XC16                              300180
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)          300190
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)                             300200
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(2),NH            300210
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)   300220
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB  300230
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE  300240
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS, N1,KBC,NRINGS             300250
      CØMMØN /NAM1/ FACE(4),STRGØ(7),THERM(4),MATER(3),SEGTAB(12)        300260
      CØMMØN /LYCØRR/ YCØRR(80)                                          300270
      CØMMØN /MAGIK/ KKNT                                                300280
      CØMMØN /EQUAZN/ YPRED(80),YDØT(80),YASAVE(80),                     300290
     1                YANTH,YAMTH,YAMPT,YAJPH,                           300300
     2                S,SN,CS,SNSQ,CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,         300310
     3                X1RØ,X1RØSQ,X1SNRØ,X1CSRØ,CN1RØ,SN1RØ,CS1RØ,       300320
     4                X1R1,X1R2,CS1R1,CS1R2,SN1R1,X1R1SQ,R2SQ,RØ,BESQ,   300330
     5   RØSQ,XNSQ,BETA,R1,R2,S1,R1DØT,                                  300340
     6                XNTTH,XNTPH,XMTTH,XMTPH,XFTHLD,XFPHLD,XFZELD,      300350
     7 XMTHLD,XMPHLD,ETHET(2),EPHI(2),XGPT(2),ALPHTH(2),ALPHPH(2),DUM,   300360
     8                XNUTP,XNUPT,XC11,XC22,XC15,XD33,XD22,XD21,XD12,    300370
     9                XK11,XK12,XK21,XK22,XK33,XD11,                     300380
     A                XNPHI,M,I,BETTA,ZETTA,SAVY(8),XC16                 300390
      CØMMØN /SPLINS/ ANG,PSI(100),RAD(100),CUR1(100),CUR2(100),         300400
     1        DR1DP(100),Z(14),RI(14),NRZIN                              300410
      CØMMØN /ARING/ NRING(28),AMAT(30,4)                                300420
      DIMENSIØN LST(13),YDEV(80),YICS(80),YNEW(80)                       300430
      DIMENSIØN TBDEL(80),FWDEL(80)                                      300440
      DIMENSIØN ST(72,31), XLAYER(10)                                    300450
      DIMENSIØN TMPAV(5)                                                 300460
 1726 FØRMAT(1H1)                                                        300470
      IF(Q.EQ.1) GØ TØ 191                                               300510
      READ(5,1001,END=9998) RGØ,ANG,STØRY                                300520
 1001 FØRMAT(F2.0,A1,16A4)                                               300530
      WRITE(1) RGØ,ANG,STØRY                                             300540
      READ(5,1002) DTAU,DIFF,STEP
 1002 FØRMAT(3D14.1)
      DELTA = 0.D0
      WRITE(1) DTAU,DIFF,STEP,DELTA                                      300570
      IF (RGØ.EQ.14.0) GØ TØ 180                                         300580
      READ(5,1006) G1,G2,G3
 1006 FØRMAT(3E14.1)
      WRITE(1)      G1,G2,G3                                             300600
      GØ TØ 481                                                          300610
```

```
  180 READ(5,198) NRZIN,(ZI(J),RI(J),J=1,NRZIN)
  198 FØRMAT(I2,7F10.0/7F10.0)
      WRITE(1) NRZIN,(ZI(J),RI(J),J=1,NRZIN)
  481 CØNTINUE
      READ(5,1003) TYPE,HLAYR,SHEET,INTERP,RANKIN,TEFREE,NP
 1003 FØRMAT(5(A4,6X),E10.1,10X,I2)
      IF(NP.LT.2.ØR.NP.GT.30) GØ TØ 8787
      WRITE(1) TYPE,HLAYR,SHEET,INTERP,RANKIN,TEFREE,NP
      GØ TØ 192
  191 READ(1) RGØ,ANG,STØRY
      READ(1) DTAU,DIFF,STEP,DELTA
      IF (RGØ.EQ.14.0) GØ TØ 182
      READ (1      ) G1,G2,G3
      GØ TØ 183
  182 READ(1) NRZIN,(ZI(J),RI(J),J=1,NRZIN)
  183 CØNTINUE
      READ(1) TYPE,HLAYR,SHEET,INTERP,RANKIN,TEFREE,NP
  192 EPSIL =1.0E-05
      DIFF  =1.0E-04
      ERR = 1.0 E-07
      I = RGØ
      IF (NH.NE.0) GØ TØ 920
      WRITE(6,651) NSC,I,STØRY,DTAU,DIFF,STEP,DELTA
  651 FØRMAT(//13X,15HSEGMENT NUMBER ,I2,5X,13HSEGMENT CØDE ,I2,5X,
     1   16A4//22X,4HDTAU,15X,4HDIFF
     2,15X,4HSTEP,10X,5HDELTA//16X,5(E14.7,5X),2X,F2.0)
      IF (RGØ.EQ.14.0) GØ TØ 185
      WRITE(6,652)  G1,G2,G3
  652 FØRMAT(//54X,24HGEØMETRY INPUT VARIABLES,//38X,3(E14.7,5X))
      GØ TØ 645
  185 WRITE(6,186) (ZI(I),RI(I),I=1,NRZIN)
  186 FØRMAT(//57X,24HGEØMETRY INPUT VARIABLES//42X,16HAXIAL CØØRDINATE,
     1       9X,6HRADIUS/50X,1HZ,20X,1HR/(43X,1P1E15.8,5X,1P1E15.8))
  645 WRITE(6,653) TYPE,HLAYR,SHEET,INTERP,RANKIN,TEFREE,NP
  653 FØRMAT(//12X,5(A4,6X),9HT FREE = ,E10.3,12X,
     1        26HNUMBER ØF TABLE CØLUMNS = ,I2)
  920 CØNTINUE
C     MATERIAL PRØPERTY IDENTIFICATIØN
      DØ 501 I=1,NMPT
      IF (HLAYR-STD(I)) 501,502,501
  502 MAT=I
      GØTØ 503
  501 CØNTINUE
      GØTØ 8036
C     GEØMETRY IDENTIFICATIØN SEARCH
  503 DØ 504 I = 1,7
      IF(RGØ-STRGØ(I)) 504,505,504
  504 CØNTINUE
      GØTØ 8086
  505 KGEØM=I
      DØ 506 I=1,3
      IF(TYPE-MATER(I))506,507,506
  506 CØNTINUE
      GØTØ 8087
  507 ITYPE=I
      DØ 510 I=1,12
      IF(INTERP-SEGTAB(I))510,511,510
  510 CØNTINUE
      GØ TØ 8088
  511 ISTTAB=I
      DØ 508 I=1,4
```

```
      IF (SHEET.EQ.FACE(I)) GØTØ 509
  508 CØNTINUE
      GØTØ 8089
  509 THICK=I
      KLUE2=1
      GØ TØ (430,430,420,420,420,420,425,425,425, 430,430,430),ISTTAB
  420 KLUE2=2
      GØ TØ 430
  425 KLUE2=3
  430 KLUE1=THICK
C     TEMPERATURE LØAD IDENTIFICATIØN
      DØ 401 I=1,4
      IF(RANKIN.EQ.THERM(I))GØTØ 402
  401 CØNTINUE
      GØTØ 8090
  402 KELVIN=I
C     LINEAR ANALYSIS IDENTIFICATIØN
      IANLYZ = 1
      NRØW = THICK + 1
      IF (ISTTAB.EQ.1) NRØW = 11
      IF (ISTTAB.EQ.3) NRØW = 13
      IF (ISTTAB.EQ.4) NRØW = 8
      IF (ISTTAB.EQ.5) NRØW = 9
      IF (ISTTAB.EQ.6) NRØW = 10
      IF (ISTTAB.EQ.7) NRØW = 7
      IF (ISTTAB.EQ.8) NRØW = 8
      IF (ISTTAB.EQ.9) NRØW = 9
      IF (ISTTAB.EQ.10) NRØW = 12
      IF (ISTTAB.EQ.11) NRØW = 13
      IF (ISTTAB.EQ.12) NRØW = 14
      IF (KBC.NE.0) NRØW = NRØW+2*NLCASE
      L= 2*(MAT-1)+1
      II=NXMAT(L)
      III=NXMAT(L+1)
      IF (NH.NE.0) GØ TØ 921
      WRITE(6,654)  ((XMAT(I,J),J=1,10),I=II,III)
  654 FØRMAT(//51X,28HMATERIAL PRØPERTY TABLE USED,//(10(1H ,E12.5)))
      WRITE(6,655)
  655 FØRMAT(//42X, 47HTABLE ØRDER PHI ØR S VS. CRØSSECTIØN PRØPERTIES,)
  921 CØNTINUE
       DØ 901  I=1,NRØW
      IF(Q.EQ.1)  GØ TØ 193
      READ (5,1005) (ST(I,J),J=1,NP)
 1005 FØRMAT (5E14.7)
      WRITE(1)       (ST(I,J),J=1,NP)
      IF (NH.NE.0) GØ TØ 901
      IF (KBC.EQ.0) GØ TØ 194
      IF (I.EQ.NRØW-2*NLCASE+1) WRITE(6,298)
  298 FØRMAT(//42X,48HTABLE ØRDER PHI ØR S VS. INPUT STRESS RESULTANTS)
  194 WRITE(6,600) (ST(I,J),J=1,NP)
  600 FØRMAT(1H ,8(E14.7,2X)/(3X,8(E14.7,2X)))
      GØ TØ 901
  193 READ (1      ) (ST(I,J),J=1,NP)
  901 CØNTINUE
      DØ 750 JJ=1,12
  750 LST(JJ) = 0
      IF (KBC.NE.0) GØ TØ 590
      K=NRØW+1
      JJ=1
      JJJ=6
      MM=1
```

```
      NRW = NRØW                                                        301841
      DØ 17 NLC=1,NLCASE                                                301840
      JT = JJ                                                           301850
      JTT= JJJ                                                          301860
      L=0                                                               301870
      IF(Q.EQ.1)  GØ TØ 195                                             301880
      READ(5,1004) (LST(J),J=JJ,JJJ)                                    301890
 1004 FØRMAT(6I1)                                                       301900
      WRITE(1) (LST(J),J=JJ,JJJ)                                        301910
      GØ TØ 196                                                         301920
  195 READ(1) (LST(J),J=JJ,JJJ)                                         301930
  196 CØNTINUE                                                          301940
      IF(LST(JJ))8031,19,20                                             301950
   20 L = LST(JJ)                                                       301960
      IF (NLC.GT.1.AND.LST(1).NE.0.AND.LST(JT).NE.0) GØ TØ 8008         301970
   19 JJ=JJ+1                                                           301980
   23 IF(LST(JJ))8031,22,21                                             301990
   21 L=L+1                                                             302000
   22 IF(JJ.EQ.JJJ) GØTØ 24                                             302010
      JJ=JJ+1                                                           302020
      GØTØ 23                                                           302030
   24 IF(L.EQ.0) GØ TØ 71                                               302040
      KK = K + L - 1                                                    302050
      DØ 72 M=K,KK                                                      302060
      IF(Q.EQ.1)  GØ TØ 197                                             302070
      READ (5,1005) (ST(M,J),J=1,NP)                                    302080
      WRITE(1)      (ST(M,J),J=1,NP)                                    302090
      GØ TØ 72                                                          302100
  197 READ (1      ) (ST(M,J),J=1,NP)                                   302110
   72 CØNTINUE                                                          302120
      IF (LST(JT).EQ.0) GØ TØ 660                                       302130
      LY = K                                                            302140
      KY = K                                                            302150
      KZ = K+LST(1)-1                                                   302160
      K = KZ+1                                                          302170
      IF (NH.NE.0) GØ TØ 665                                            302180
      WRITE(6,656)                                                      302190
  656 FØRMAT(//45X,42HTABLE ØRDER PHI ØR S VS. TEMPERATURE LØADS,)      302200
      DØ 657 N=KY,KZ                                                    302210
      WRITE(6,600) (ST(N,J),J=1,NP)                                     302220
  657 CØNTINUE                                                          302230
  660 IF((L-LST(JT)).EQ.0) GØ TØ 665                                    302240
      IF (NH.NE.0) GØ TØ 665                                            302250
      WRITE(6,661) NLC                                                  302260
  661 FØRMAT(//16X,8HPRØBLEM ,I2,5X,84HTABLE ØRDER  PHI ØR S VS. DISTRIB 302270
     1UTED LØADS (F THETA, F PHI, F ZETA, M THETA, M PHI),)             302280
      WRITE(6,1968) (LST(J),J=JT,JTT)                                   302290
 1968 FØRMAT(27H LØAD IDENTIFICATIØN CLUES ,6I1/)                       302300
      DØ 662 N = K, KK                                                  302310
      WRITE(6,600) (ST(N,J),J=1,NP)                                     302320
  662 CØNTINUE                                                          302330
  665 CØNTINUE                                                          302340
   71 K = K + L - LST(JT)                                               302350
      IF (NLC.EQ.1.AND.LST(1).EQ.0) NRW = K-1                           302361
      JJ=JJJ+1                                                          302360
      JJJ=JJ+5                                                          302370
   17 MM=MM+1                                                           302380
  590 CØNTINUE                                                          302390
      IF (Q.EQ.1) GØ TØ 2004                                            302400
      READ (5,591) IS,SAVJTC(IS),SAVSTP(IS),(STØRY(I),I=1,16)           302410
  591 FØRMAT (3I5,16A4)                                                 302420
```

```
      READ(5,2000)                                                      302430
 2000 FØRMAT(1X)                                                        302440
      WRITE(1) IS,SAVJTC(IS),SAVSTP(IS),STØRY                           302450
      GØ TØ 2005                                                        302460
 2004 READ(1) IS,SAVJTC(IS),SAVSTP(IS),STØRY                            302470
 2005 CØNTINUE                                                          302480
      ITIC = SAVJTC(IS)                                                 302490
      ISTØP = SAVSTP(IS)                                                302500
      JTIC = JRTIC(NRC)                                                 302510
      JSTØP = JRSTØP(NRC)                                               302520
      TIC = ST(1,1)                                                     302530
      STØP = ST(1,NP)                                                   302540
      NEQNS=64+8*NPRØB                                                  302550
      DØ 73 I=1,NEQNS                                                   302560
   73 YICS(I)=0.0                                                       302570
      YICS(5) =1.0                                                      302580
      YICS(14)=1.0                                                      302590
      YICS(23)=1.0                                                      302600
      YICS(32)=1.0                                                      302610
      YICS(33)=1.0                                                      302620
      YICS(42)=1.0                                                      302630
      YICS(51)=1.0                                                      302640
      YICS(60)=1.0                                                      302650
      NCYC=0                                                            302660
      NSAVE=NRØW                                                        302670
      IEND=0                                                            302680
      PRINT=TIC                                                         302690
      DTA=DTAU                                                          302700
      DTAU = 0.D0
      IF (NH.NE.0.AND.KBC.EQ.0) READ(13) SAVY                           302720
 2001 FØRMAT(1X,1P1E16.7,I5,1P6E16.7)                                   302730
   59 CALL SETUP (MAGIN,MAGØUT,TIC,STEP,NEQNS,DTAU,EPSIL,DELTA,ERR,TIME, 302760
     1DTIME,YICS,YPRED,YCØRR,YDØT,YNEW,YDEV,FWDEL,TBDEL)                302770
      GØTØ 61                                                           302780
   60 CØNTINUE
      CALL MAGIC (MAGIN,MAGØUT,TIC,STEP,NEQNS,DTAU,EPSIL,DELTA,ERR,TIME,
     1            DTIME,YICS,YPRED,YCØRR,YDØT,YNEW,YDEV,FWDEL,TBDEL)
   61 IF(MAGØUT.LE.0) GØTØ 25                                           302820
      IF(TIME.GT.STØP) GØTØ 62                                          302830
      IF(TIME.LT.STØP) GØTØ 63                                          302840
   64 IEND=-1                                                           302850
      GØTØ 67                                                           302860
   62 IF(TIME.LE.(STØP+DIFF)) GØTØ 64                                   302870
      GØTØ 8001                                                         302880
   63 IF((STØP-DIFF).LE.TIME) GØTØ 64                                   302890
      IF((TIME+DTIME).GT.STØP) GØTØ 65                                  302900
      IF(PRINT.GT.TIME) GØTØ 66                                         302910
      PRINT=TIME+DTA                                                    302920
   67 CØNTINUE                                                          302930
      IF(IEND.GT.0) GØTØ 8002                                           302940
      IF(IEND.LT.0) GØTØ  150                                           302950
   66 CØNTINUE                                                          302960
      MAGIN = 0                                                         302970
      GØTØ 60                                                           302980
   65 DTIME=STØP-TIME                                                   302990
      DELTA = 0.D0
      GØTØ 67                                                           303010
   75 NCYC=NCYC+1                                                       303020
      MAGIN=-1                                                          303030
      GØTØ 60                                                           303050
   25 LT=0                                                              303060
```

```
      IF (NH.NE.0.AND.KKNT.EQ.4.AND.KBC.EQ.0) READ(13) SAVY
      JJ = NLCASE*6
      DØ 15  J=1,JJ
   15 LT=LT+LST(J)
  296 NTØTAL = LT+NSAVE
      PHI=TIME
      ARG=PHI
      LL=NP+1
      DØ 51 I=1,NP
      IF(ARG-ST(1,I)) 52,55,51
   52 IF(I-1) 55,55,54
   51 CØNTINUE
      I=NP
      GØ TØ 55
   54 DØ 57 IK=2,NTØTAL
   57 ST(IK,LL)=ST(IK,I-1)+(ST(IK,I)-ST(IK,I-1))*(ARG-ST(1,I-1))/(ST(1,I
     1)-ST(1,I-1))
      GØTØ 80
   55 DØ 58 IK=2,NTØTAL
   58 ST(IK,LL)=ST(IK,I)
   80 CØNTINUE
C     THE UPDATED INTERPØLATED VALUES ØF THE MATERIAL PRØPERTY CØEFFIC
C     IENTS ARE FØUND IN THE XMAT TABLE AND STØRED IN THE XLAYER ARRAY
      L = (MAT-1)*2+1
      II=NXMAT(L)
       III=NXMAT(L+1)
      LL=NP+1
      L=NRØW + 1
      IF(KELVIN .NE. 1)GØ TØ 81
      IF(THICK.NE.1)GØ TØ 83
   81 LØØP=1
      ILØW=1
      IHIGH = 1
      IF(KELVIN .NE. 1)GØ TØ 85
   82 CØNTINUE
      TMPAV(ILØW)=(ST(L,LL)+ ST(L+1,LL)+ ST(L+2,LL) + ST(L+3,LL))/4.0
      GØ TØ 85
   83 LØØP = 2
      ILØW= 1
      IHIGH = 2
      TMPAV(ILØW)= (ST(L,LL)+ ST(L+1,LL))/2.0
      TMPAV(IHIGH)=(ST(L+2,LL) + ST(L+3,LL))/2.0
   85 DØ 105 IL=ILØW,IHIGH
      M=1
      GØTØ (91,92,93,93),KELVIN
   91 ARG= TMPAV(IL)
      GØTØ 94
   93 CØNTINUE
      ARG = ST(NRØW+1,LL)
      TMPAV(1) = ARG
   94 DØ 104 I = 2,10
      IF (ARG-XMAT(II,I)) 121,123,104
  121 IF (I-2) 8007,8007,124
  104 CØNTINUE
      GØTØ 8067
  123 L=II+1
      DØ 122 J=L,III
      XLAYER(M)=XMAT(J,I)
  122 M=M+1
      GØTØ 111
  124 L=II+1
```

```
      DØ 125 J=L,III
      XLAYER(M)=XMAT(J,I-1)+(XMAT(J,I)-XMAT(J,I-1))*(ARG-XMAT(II,I-1))/
     1         (XMAT(II,I)-XMAT(II,I-1))
  125 M=M+1
      GØTØ 111
   92 L = II + 1
      DØ 922  J=L,III
      XLAYER(M)= XMAT(J,1)
  922 M=M+1
  111 GØ TØ (115,115,112,113,114),LØØP
  112 XNUTP= XLAYER(2)
      IF(ITYPE.NE. 1)GØ TØ 131
      XNUPT= XNUTP
      XGPT(1) = ETHET(1)/(2*(1+ XNUPT))
      XGPT(2) = ETHET(2)/(2*(1+ XNUPT))
      GØ TØ 106
  131 XNUTP = XLAYER(3)
      XNUPT = ETHET(1)*XNUTP/EPHI(1)
      GØ TØ 106
  113 ES= XLAYER(8)
      ALPHS=XLAYER(10)
      GØ TØ 106
  114 ALPHR = XLAYER(9)
      ER = XLAYER(7)
      GØ TØ 118
  115 GØ TØ(101,102,103),ITYPE
  101 ETHET(IL)= XLAYER(1)
      XNUTP = XLAYER(2)
      ALPHTH(IL)= XLAYER(3)
      EPHI(IL) = ETHET(IL)
      XNUPT= XNUTP
      ALPHPH(IL)= ALPHTH(IL)
      XGPT(IL)= ETHET(IL)/(2.0*(1.0+ XNUPT))
      GØ TØ 105
  102 ETHET(IL)= XLAYER(1)
      EPHI(IL) = XLAYER(2)
      XNUTP = XLAYER(3)
      ALPHTH(IL)= XLAYER(4)
      ALPHPH(IL)= XLAYER(5)
      XGPT(IL) = XLAYER(6)
      XNUPT= ETHET(IL)* XNUTP/EPHI(IL)
      GØ TØ 105
  103 ETHET(IL)= XLAYER(1)
      EPHI(IL)= XLAYER(2)
      XNUTP= XLAYER(3)
      ALPHTH(IL) = XLAYER(4)
      ALPHPH(IL) = XLAYER(5)
      XGPT(IL) = XLAYER(6)
      ER= XLAYER(7)
      ES =XLAYER(8)
      ALPHR = XLAYER(9)
      ALPHS = XLAYER(10)
      XNUPT = ETHET(IL) * XNUTP/EPHI(IL)
  105 CØNTINUE
  106 L = NRØW+1
      GØ TØ (117,107,108,119,118),LØØP
  107 LØØP= 3
      ILØW = 3
      IHIGH= 3
      GØ TØ 82
  108 IF(ITYPE .EQ.3 .AND. ISTTAB .GE. 3)GØ TØ 109
```

```
      GØ TØ 118
  109 LØØP= 4
      ILØW =4
      IHIGH = 4
      CPH = ST(3,LL)
      IF(ISTTAB.GE. 10.AND. ISTTAB.LE. 12)CPH = ST(6,LL)
      IF(CPH     .LE.0)GØ TØ 281
      TMPAV(4)= ST(L,LL)
      GØ TØ 85
  281 TMPAV(4) =ST(L+3,LL)
      GØ TØ 85
  119 LØØP=5
      ILØW=5
      IHIGH=5
      CTH = ST(3,LL)
      IF(ISTTAB.GE. 10.AND. ISTTAB.LE. 12)CTH = ST(7,LL)
      IF(CTH     .LE. 0)GØ TØ 116
      TMPAV(5)= ST(L,LL)
      GØ TØ 85
  116 TMPAV(5)= ST(L+3,LL)
      GØ TØ 85
  117 CØNTINUE
      ETHET(2)= ETHET(1)
      ALPHTH(2)=ALPHTH(1)
      ALPHPH(2)=ALPHPH(1)
      XGPT(2)= XGPT(1)
      EPHI(2)= EPHI(1)
  118 CØNTINUE
      CALL RØBØT (ST,KLUE2,NRØW,NRW,LL,ER,ES,G2,G3,TIME,ITIC,JTIC,NCYC)
      IF (NIX.NE.0) GØ TØ 9999
C     CØMPUTATIØN ØF K AND D FØR K AND D INPUT
      LL=NP+1
      IF(XK11.EQ.0.0) GØTØ 8101
      IF(ITYPE.EQ.3.AND.XK12.EQ.0.) GØ TØ 8102
      IF(ITYPE.EQ.3.AND.XK21.EQ.0.) GØ TØ 8103
      IF(XK22.EQ.0.0) GØTØ 8104
      IF(XK33.EQ.0.0) GØTØ 8105
      IF(XD11.EQ.0.0) GØTØ 8106
      IF(ITYPE.EQ.3.AND.XD12.EQ.0.) GØ TØ 8107
      IF(ITYPE.EQ.3.AND.XD21.EQ.0.) GØ TØ 8108
      IF(XD22.EQ.0.0) GØTØ 8109
      IF(XD33.EQ.0.0) GØTØ 8110
      NL=0
      XSAVE1 = XNTTH
      XSAVE2 = XNTPH
      XSAVE3 = XMTTH
      XSAVE4 = XMTPH
      XNTTH = 0.0
      XNTPH = 0.0
      XMTTH = 0.0
      XMTPH = 0.0
      XFTHLD=0.0
      XFPHLD=0.0
      XFZELD=0.0
      XMTHLD=0.0
      XMPHLD=0.0
      JF=8+NPRØB
      K = NRØW
      NLCSE = NLCASE
      IF (NH.EQ.0) NLCSE = 1
      XFPHL1 = 0.0
```

```
      XFZEL1 = 0.0
      XFPHL2 = 0.0
      XFZEL2 = 0.0
C     ANALYS=LINE
C     ANALYS=ØMTH
C     ANALYS=NPH
      XNPHI= 0.0
      DØ 77 M=1, JF
      I = (M-1)*8 + 1
      IF (I.EQ.1.AND.NH.NE.0) GØ TØ 252
      IF (M.LT.9) GØTØ   49
      IF (M.EQ.9.AND.LST(1).EQ.0) GØ TØ 252
      XNTTH = XSAVE1
      XNTPH = XSAVE2
      XMTTH = XSAVE3
      XMTPH = XSAVE4
  252 DØ 250 JKL=1,NLCSE
      NL=NL+1
      XFTHLD=0.0
      XFPHLD=0.0
      XFZELD=0.0
      XMTHLD=0.0
      XMPHLD=0.0
      IR=NL*6-5
      IF(LST(IR).NE.0) K=K+LST(IR)
      IF (LST(IR+1).EQ.0) GØTØ 44
      K=K+1
      XFTHLD=ST(K,LL)
   44 IF(LST(IR+2).EQ.0) GØTØ 45
      K=K+1
      XFPHLD=ST(K,LL)
   45 IF(LST(IR+3).EQ.0) GØTØ 46
      K=K+1
      XFZELD=ST(K,LL)
   46 IF(LST(IR+4).EQ.0) GØTØ 47
      K=K+1
      XMTHLD=ST(K,LL)
   47 IF(LST(IR+5).EQ.0) GØTØ 48
      K=K+1
      XMPHLD=ST(K,LL)
   48 CØNTINUE
      IF (JKL.EQ.2) GØ TØ 251
      XFPHL1 = XFPHLD
      XFZEL1 = XFZELD
  251 XFPHL2 = XFPHLD
      XFZEL2 = XFZELD
  250 CØNTINUE
   49 IF(ISTTAB.GE.3.AND.ISTTAB.LE.9)GØ TØ 4002
      CALL DIF1 (XFPHL1,XFZEL1,XFPHL2,XFZEL2)
      GØ TØ 77
 4002 CALL DIFF2 (XFPHL1,XFZEL1,XFPHL2,XFZEL2)
   77 CØNTINUE
      GØTØ 75
 8001 IERRØR=8001
      NERRØR=11
      GØTØ 8888
 8002 IERRØR=8002
      NERRØR=12
      GØTØ 8888
 8007 IERRØR=8007
      NERRØR=15
```

```
      GØTØ 8888
 8008 IERRØR = 8008
      NERRØR=10
      GØ TØ 8888
 8031 IERRØR=8031
      NERRØR= 9
      GØTØ 8888
 8036 IERRØR=8036
      NERRØR = 2
      GØTØ 8888
 8086 IERRØR=8C86
      NERRØR= 3
      GØTØ 8888
 8087 IERRØR=8C87
      NERRØR= 4
      GØTØ 8888
 8088 IERRØR=8088
      NERRØR=27
      GØTØ 8888
 8089 IERRØR=8089
      NERRØR= 5
      GØTØ 8888
 8090 IERRØR=8C90
      NERRØR= 6
      GØTØ 8888
 8067 IERRØR= 8067
      NERRØR=16
      GØTØ 8888
 8101 IERRØR = 8101
      NERRØR=17
      GØTØ 8888
 8102 IERRØR = 8102
      NERRØR=18
      GØTØ 8888
 8103 IERRØR = 8103
      NERRØR=19
      GØTØ 8888
 8104 IERRØR = 8104
      NERRØR=20
      GØTØ 8888
 8105 IERRØR = 8105
      NERRØR=21
      GØTØ 8888
 8106 IERRØR = 8106
      NERRØR=22
      GØTØ 8888
 8107 IERRØR = 8107
      NERRØR=23
      GØTØ 8888
 8108 IERRØR = 8108
      NERRØR=24
      GØTØ 8888
 8109 IERRØR = 8109
      NERRØR=25
      GØTØ 8888
 8110 IERRØR = 8110
      NERRØR=26
      GØTØ 8888
 8787 IERRØR = 8787
      NERRØR=34
 8888 NIX=1
```

```
      RETURN
  150 CØNTINUE
      IF (NH.NE.0) GØ TØ 925
      WRITE(6,670)
  670 FØRMAT(//46X,41HMATRIX X AND Y (TRANSPØSED)  MAGIC ØUTPUT)
      WRITE(6,672)  (YCØRR(I),I=1,NEQNS)
  672 FØRMAT(8(2X,E14.7))
  925 CØNTINUE
      RESTØP=RØ
      RADUS(ISTØP) = RØ
      TADUS(ISTØP)=RØ
      AMAT(ISTØP,1) = SAVY(7)
      AMAT(ISTØP,2) = SAVY(8)
      IF(NSC.LT.NSEG) GØ TØ 9999
      SADUS(JSTØP) = RØ
      UADUS(JSTØP)=RØ
      AMAT(JSTØP,3) = SAVY(7)
      AMAT(JSTØP,4) = SAVY(8)
      IF(ITIC.LE.ISTØP) GØ TØ 9999
      SADUS(JSTØP)=RADUS(ITIC)
      UADUS(JSTØP)=RADUS(ITIC)
 9999 CØNTINUE
      RETURN
 9998 WRITE(6,9997)
 9997 FØRMAT(-THE PRØGRAM HAS PRØCESSED ALL THE DATA FØR A CHAIN ØF UNCØ
     1UPLED SEGMENTS-)
      STØP
       END
```

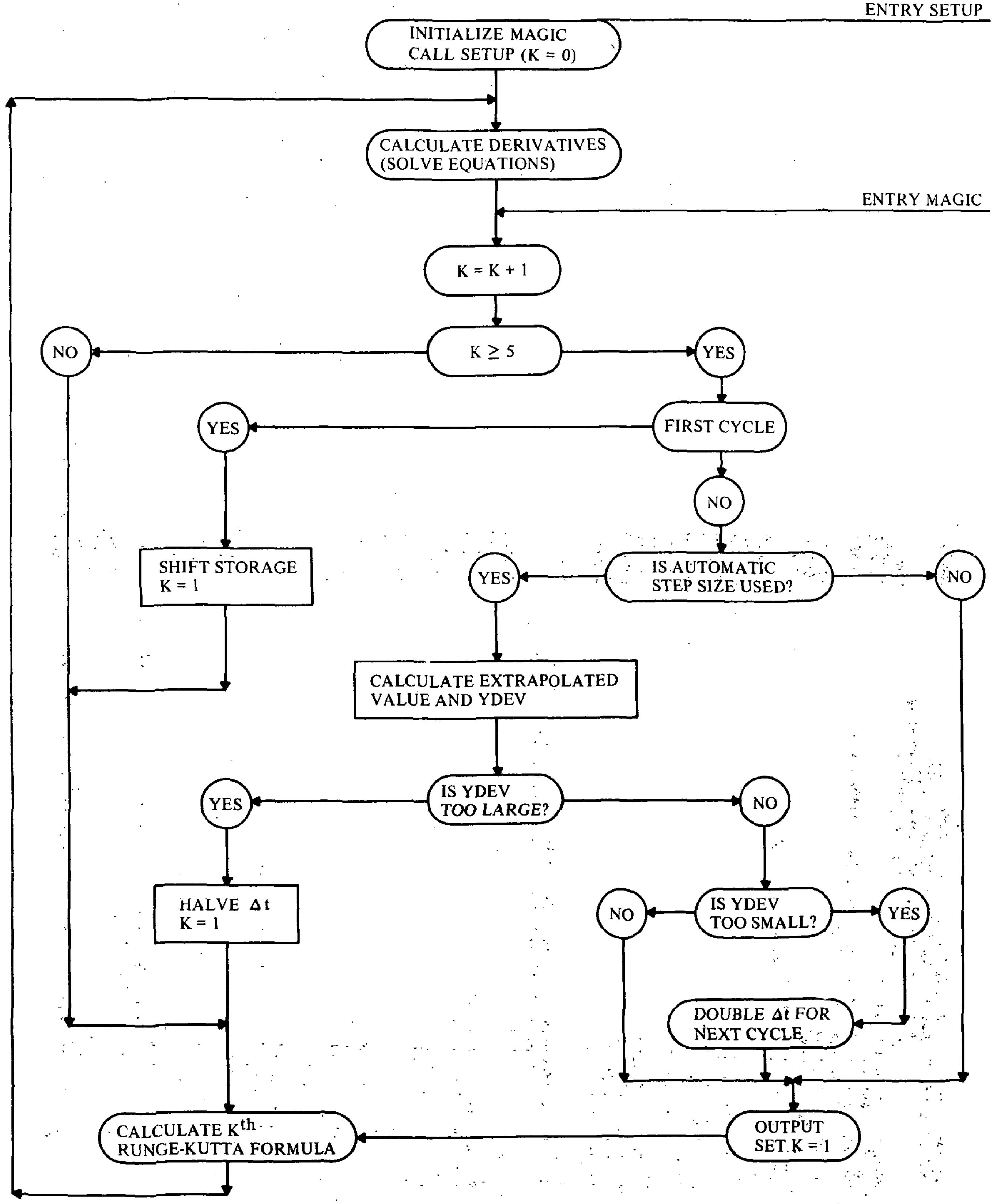
SUBROUTINE SETUP

SETUP is a double entry subroutine called from RIEMAN. It is a mixed precision, numerical integration routine, with automatic selection of a variable integration step size, which utilizes fifth order Runge-Kutta equations to obtain the solution for first order differential equations.

SUBROUTINE MAGIC

MAGIC is an alternate entry point to subroutine SETUP.

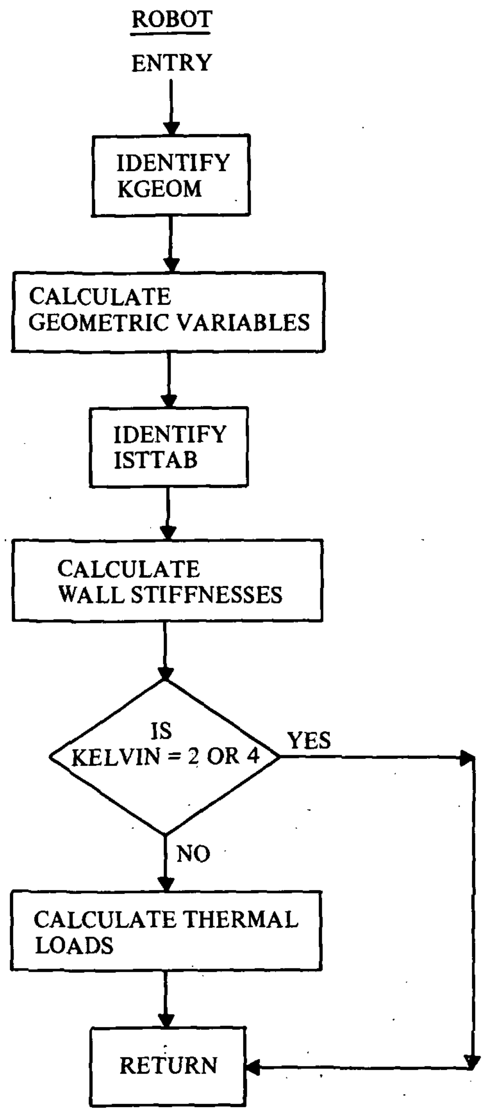
RUNGE-KUTTA GENERAL FLOW CHART



```
C ..... RØUTINE **D4       ** ABACUS UPDATED 07/07/72 .....              400000
      SUBRØUTINE SETUP (MAGIN,MAGØUT,TIC,STEP,NEQNS,DTAU,
     1                  EPSIL,DELTA,ERR,TIME,DTIME,YICS,YPRED,
     2                 YCØRR,YDØT,YNEW,YDEV,FWDEL,TBDEL)                400030
      IMPLICIT REAL*8 (A-H,Ø-Z)                                         400040
      ABS(X) = DABS(X)                                                  400050
      DIMENSIØN YICS(1),YPRED(1),YCØRR(1),YDØT(1),YNEW(1),              400060
     1          YDEV(1),FWDEL(1),TBDEL(1)
      DIMENSIØN C(3),D(3)                                               400090
      CØMMØN /MAGIK/ KKNT                                               400100
      DØUBLE PRECISIØN YNEW,YPRED                                       400110
      DATA C,D/.5D0,.5D0,1.0D0,.5D0,0.D0,.5D0/
      TIME = TIC                                                        400130
      TAU  = TIC                                                        400140
      IF (DELTA)200,201,200                                             400150
  200 DTIME = 0.0078125                                                 400160
      GØ TØ 225                                                         400170
  201 DTIME = STEP                                                      400180
  225 DØ 102 I = 1,NEQNS                                                400190
      YDEV(I)  = 0.0                                                    400200
      YPRED(I) = YICS(I)                                                400210
      YCØRR(I) = YICS(I)                                                400220
  102 YNEW(I)  = YICS(I)                                                400230
      MAGØUT   =-2                                                      400240
      GØ TØ 264                                                         400250
 5555 CØNTINUE                                                          400260
      ENTRY MAGIC (MAGIN,MAGØUT,TIC,STEP,NEQNS,DTAU,EPSIL,DELTA,ERR,
     1             TIME,DTIME,YICS,YPRED,YCØRR,YDØT,YNEW,YDEV,FWDEL,
     2             TBDEL)
 5556 CØNTINUE                                                          400280
      MSET = 2                                                          400290
      IF (MAGØUT) 305,101,101                                           400300
  101 IF(MAGIN) 21, 27, 14                                              400310
   27 K = 0                                                             400320
      DØ 202 I = 1,NEQNS                                                400330
  202 YNEW(I)  = YPRED(I)                                               400340
   21 K = K +1                                                          400350
      KKNT = K                                                          400360
  210 DØ  2  I = 1,NEQNS                                                400370
      GØ TØ (9,6,7,4,11),K                                              400380
    9 FWDEL(I) = YDØT(I)                                                400390
      GØ TØ 105                                                         400400
    6 TBDEL(I) = YDØT(I)                                                400410
      GØ TØ 105                                                         400420
    7 TBDEL(I) = TBDEL(I) + YDØT(I)                                     400430
  105 YPRED(I) = YNEW(I) + C(K)*DTIME*YDØT(I)                           400440
      GØ TØ (2,2,400),K                                                 400450
  400 YCØRR(I) = YPRED(I)                                               400460
    2 CØNTINUE                                                          400470
      TIME     = TIME + D(K)*DTIME                                      400480
   99 MAGØUT   = 0.0                                                    400490
  264 RETURN                                                            400500
    4 DØ  8  I = 1,NEQNS                                                400510
      YPRED(I) = YNEW(I) + DTIME*(FWDEL(I) + 2.*TBDEL(I) + YDØT(I))/6.  400520
    8 YDEV(I)  = YCØRR(I) - YPRED(I)                                    400530
      GØ TØ 99                                                          400540
   11 IF (DELTA)80, 5,80                                                400550
   80 DØ  13 I = 1,NEQNS                                                400560
      IF (EPSIL* ABS(YCØRR(I)) + ERR   -  ABS(YDEV(I)))14, 13, 13       400570
   13 CØNTINUE                                                          400580
```

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1)
RO	r_0
R1	r_1
R1DOT	$r_{1,\phi}$
CS	$\cos\phi$
SN	$\sin\phi$
A	a
C	c
XN	n
F2	f_2
F3	f_3
TAN; TN	$\tan\phi$
SEC	$\sec\phi$
TII	T_{ii}
TIK	T_{ic}
TOK	T_{oc}
TOO	T_{oo}
TEFREE	$\overline{T}$
HI	h_i
HO	h_o
T	t
TI	t_i
TO	t_o
SNSQ	$\sin^2\phi$
CSSQ	$\cos^2\phi$
CN	$\cos\phi \sin\phi$
X1CS	$1/\cos\phi$
X1SN	$1/\sin\phi$
R2	r_2
BETA	β

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1)
X1ROSN	$1/r_0 \sin \phi$
X1ROCS	$1/r_0 \cos \phi$
CSX1RO	$\cos \phi/r_0$
CSX1R1	$\cos \phi/r_1$
CSX1R2	$\cos \phi/r_2$
SNX1RO	$\sin \phi/r_0$
SNX1R1	$\sin \phi/r_1$
X1R1	$1/r_1$
X1R2	$1/r_2$
X1R1SQ	$1/r_1^2$
X1ROSQ	$1/r_0^2$


ROBOT
ENTRY
IDENTIFY KGEOM
CALCULATE GEOMETRIC VARIABLES
IDENTIFY ISTTAB
CALCULATE WALL STIFFNESSES
IS KELVIN = 2 OR 4
YES
NO
CALCULATE THERMAL LOADS
RETURN

```
C ..... RØUTINE ** RØBØT  ** ABACUS UPDATED 07/24/72 .....                 2600000
      SUBRØUTINE RØBØT (ST,KLUE2,NRØW,NRW,LL,ER,ES,G2,G3,TIME,ITIC,JTIC,   2500010
     1                  NCYC)                                              2500020
      INTEGER SAVJTC,SAVSTP,Q,THICK
      INTEGER XN1,XN2,XN                                                   2500040
      REAL*4 I2
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK                    2500060
      DØUBLE PRECISIØN TEMP1,TEMP2,TEMP3,TEMP4,TEMP5,TEMP8,TEMP10,TEMP11
      DØUBLE PRECISIØN YDØT,YASAVE,YANTH,YAMTH,YAMPT,YAJPH,S,SN,CS,SNSQ,   2500090
     1                 CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,X1RØ,X1RØSQ,X1SNRØ,    2500100
     2                 X1CSRØ,CN1RØ,SN1RØ,CS1RØ,X1R1,X1R2,CS1R1,CS1R2,     2500110
     3                 SN1R1,X1R1SQ,R2SQ,RØ,BESQ,RØSQ,XNSQ,R1,R2,S1,       2500120
     4                 R1DØT,XNTTH,XNTPH,XMTTH,XMTPH,XC11,XC22,XC15,       2500130
     5                 XD33,XD22,XD21,XD12,XK11,XK12,XK21,XK22,XK33,       2500140
     6                 XD11,XNPHI,BETA,XC16
      DØUBLE PRECISIØN YPRED,TIME
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)            2500170
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)                               2500180
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(2),NH              2500190
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)     2500200
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB    2500210
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE    2500220
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS               2500230
      CØMMØN /EQUAZN/ YPRED(80),YDØT(80),YASAVE(80),YANTH,YAMTH,           2500240
     1        YAMPT,YAJPH,S,SN,CS,SNSQ,CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,       2500250
     2        X1RØ,X1RØSQ,X1SNRØ,X1CSRØ,CN1RØ,SN1RØ,CS1RØ,X1R1,X1R2,       2500260
     3        CS1R1,CS1R2,SN1R1,X1R1SQ,R2SQ,RØ,BESQ,RØSQ,XNSQ,BETA,R1,     2500270
     4        R2,S1,R1DØT,XNTTH,XNTPH,XMTTH,XMTPH,XFTHLD,XFPHLD,XFZELD,    2500280
     5        XMTHLD,XMPHLD,ETHET(2),EPHI(2),XGPT(2),ALPHTH(2),            2500290
     5        ALPHPH(2),DUM,XNUTP,XNUPT,                                   2500300
     6        XC11,XC22,XC15,XD33,XD22,XD21,XD12,XK11,XK12,XK21,XK22,      2500310
     7       XK33,XD11,XNPHI,M,I,BETTA,ZETTA,SAVY(8),XC16
      CØMMØN /SPLINS/ ANG,PSI(100),RAD(100),CUR1(100),CUR2(100),           2500330
     1       DR1DP(100),ZI(14),RI(14),NRZIN                                2500340
      CØMMØN /ARING/ NRING(28),AMAT(30,4)                                  2500350
      DIMENSIØN ST(72,31)                                                  2500360
      DATA A/-A   -/                                                       2500370
      IF (KBC.EQ.0) GØ TØ 500                                              2500380
      L = 1                                                                2500390
      IF (NLCASE.EQ.1) GØ TØ 800                                           2500400
      L = 3                                                                2500410
      SAVY(4) = ST(NRØW-1,LL)                                              2500420
      SAVY(5) = ST(NRØW,LL)                                                2500430
      SAVY(6) = 0.0                                                        2500440
  800 SAVY(1) = ST(NRØW-L,LL)                                              2500450
      L = L-1                                                              2500460
      SAVY(2) = ST(NRØW-L,LL)                                              2500470
      SAVY(3) = 0.0                                                        2500480
  500 CØNTINUE                                                             2500490
C                                                                          2500500
      GØTØ (771,772,773,774,775,776,7077),KGEØM                            2500510
C     GEØMETRY FØR ELIPSE(G3=ØFFSET DISTANCE )                             2500520
  771 A=G1                                                                 2500530
      BE=G2                                                                2500540
      BETA = BE                                                            2500550
       BESQ=BE**2                                                          2500560
      ASQ=A**2                                                             2500570
      SN = DSIN(PHI)                                                       2500580
      CS = DCØS(PHI)                                                       2500590
      SNSQ = SN**2                                                         2500600
```

```
      CSSQ = CS**2
      R2 = A*DSQRT(1.0/(SNSQ+BESQ*CSSQ))
      R2SQ = R2**2
      RØ=R2*SN
      R1=R2*R2SQ*BESQ/ASQ
      BESQ=BE**2
      R1DØT=0.0
      IF(KGEØM.EQ.1.AND.BETA.NE.1.0.AND.SN.NE.0.0)R1DØT=3.0*(R2*BETA/
     1A) **2*(CS/SNSQ)*(R1*SN-RØ)
      IF(SN.EQ. 0.0)GØ TØ 779
      R2 = R2-G3/SN
      R2SQ = R2**2
      RØ = RØ-G3
      GØ TØ 7775
  779 IF(G3 .EQ. 0.0)GØ TØ 7775
      R1DØT = 3.0*G3
      RØ = -G3
      GØ TØ 7775
C     GEØMETRY FØR ØGIVE
  772 R1=G1
      C=G2
      SN = DSIN(PHI)
      CS = DCØS(PHI)
      IF (SN.EQ.0.0) GØTØ 777
      R2=R1-C/SN
      GØTØ 778
  777 R2 = 1.0
  778 RØ = R1*SN-C
      R1DØT=0.0
      GØTØ 7775
C     GEØMETRY FØR CØNE
  773 CS = CØS(G1)
      SN=SIN(G1)
      S=PHI
      S1=1.0/S
      R2=CS*SN*PHI
      RØ=PHI*CS
      R1DØT=0.0
      GØTØ 7775
C     GEØMETRY FØR CYLINDER
  774 RØ = G1
      R1DØT=0.0
      SN = 1.0
      CS = 1.0
      GØTØ 7775
C   MØDIFIED  ELLIPSE
  775 XNEXP = G1
      A    =G2
      XN1 = 1.0 + XNEXP
      XN2 = 1.0/XN1
      XN3 = XN1 + 1.0
      XN4 = XN3 + 1.0
      XN5 = XN4/XN1
      SN = DSIN(PHI)
      CS = DCØS(PHI)
      R2  = A*(2.0/(1.0+SN**XN1))**XN2
      R1  = (A/2.0)*(R2/A)**XN3
      RØ=R2*SN
      R1DØT = -XN3*A*(SN**XNEXP*CS/4.0)*(2.0/(1.0+SN**XN1))**XN5
      GØTØ 7775
C     GENERAL GEØMETRY
```

```
  776 SN = DSIN(PHI)
      CS = DCØS(PHI)
      TAN= SN/CS
      SEC= 1.0/CS
      IF (TIME.EQ.TIC) CALL GEØMET
      ARG = PHI
      DØ 204 J=1,100
      PHØ = PSI(J)
      IF (ANG.EQ.A) IF (ARG-PHØ) 221,223,204
      IF (PHØ-ARG) 221,223,204
  221 IF (J-1) 8502,8502,224
  204 CØNTINUE
      GØ TØ 8503
  223 RØ = RAD(J)
      R1 = CUR1(J)
      R2 = CUR2(J)
      R1DØT = DR1DP(J)
      GØ TØ 7775
 8502 NERRØR = 41
      GØ TØ 8888
 8503 NERRØR = 42
 8888 NIX = 1
      GØ TØ 8889
  224 SUB1 = ARG-PSI(J-1)
      SUB2 = PSI(J)-PSI(J-1)
      RØ = RAD(J-1)+(RAD(J)-RAD(J-1))*SUB1/SUB2
      R1 = CUR1(J-1)+(CUR1(J)-CUR1(J-1))*SUB1/SUB2
      R2 = CUR2(J-1)+(CUR2(J)-CUR2(J-1))*SUB1/SUB2
      R1DØT = DR1DP(J-1)+(DR1DP(J)-DR1DP(J-1))*SUB1/SUB2
      GØTØ 7775
C     ISØTENSØID GEØMETRY
 7077 CØNTINUE
      SN = DSIN(PHI)
      CS = DCØS(PHI)
      A  = G1
      R2 = A/DSQRT(SN)
      R1 = 0.5 * R2
      RØ = R2 * SN
      R1DØT = - ((A**2)*0.5)*(R1*CS)/RØ**2
 7775 TAN=SN/CS
      IF(TIME.EQ.TIC) RTICK=RØ
      IF (NCYC.GT.1) GØ TØ 491
      IF (TIME.NE.TIC) GØ TØ 491
      RADUS(ITIC) = RØ
      AMAT(ITIC,1) = SAVY(7)
      AMAT(ITIC,2) = SAVY(8)
      IF (NSC.NE.1) GØ TØ 491
      SADUS(JTIC) = RØ
      AMAT(JTIC,3) = SAVY(7)
      AMAT(JTIC,4) = SAVY(8)
  491 CØNTINUE
      RØSQ = RØ**2
      XNSQ=XN**2
      CN=CS*SN
      X1CS=1.0/CS
      TN=SN/CS
      X1RØ=1.0/RØ
      X1RØSQ=1.0/RØ**2
      X1CSRØ=1.0/(CS*RØ)
      CN1RØ=CN/RØ
      SN1RØ=SN/RØ
```

```
      CS1RØ=CS/RØ
      SNSQ=SN**2
      CSSQ=CS**2
      IF(KGEØM.EQ.4.ØR.KGEØM.EQ.3) GØTØ 79
      R1SQ = R1**2
      R2SQ = R2**2
      X1SN=1.0/SN
      X1SNRØ=1.0/(SN*RØ)
      X1R1=1.0/R1
      X1R2=1.0/R2
      CS1R1=CS/R1
      CS1R2=CS/R2
      SN1R1=SN/R1
      X1R1SQ=1.0/R1**2
   79 XNTTH=0.0
      XNTPH=0.0
      XMTTH=0.0
      XMTPH = 0.
C
C     CØMPUTATIØN ØF K AND D FØR MATERIAL PRØPETY INPUT
C
      GØ TØ (711,600,711,32,33,34,35,36,37,28,29,30),ISTTAB
C     THICK
  600 GØ TØ (703,702,701,701),THICK
  701 HØ= ST(4,LL)
  702 T = ST(3,LL)
  703 HI= ST(2,LL)
      GØ TØ 40
C     ST11,ST12,ST13
   30 HØ= ST(14,LL)
   29 T = ST(13,LL)
   28 HI= ST(12,LL)
      GJPH= ST(2,LL)
      GJTH= ST(3,LL)
      APH = ST(4,LL)
      ATH = ST(5,LL)
      CPH = ST(6,LL)
      CTH = ST(7,LL)
      XIPH = ST(8,LL)
      XITH= ST(9,LL)
      SPH = ST(10,LL)
      STH = ST(11,LL)
      GØ TØ 40
C     RWAF1,RWAF2,RWAF3
   34 HØ = ST(10,LL)
   33 T = ST(9,LL)
   32 HI = ST(8,LL)
      APH = ST(2,LL)
      CPH = ST(3,LL)
      XIPH= ST(4,LL)
      SPH = ST(5,LL)
      BETTA=ST(6,LL)
      ZETTA = ST(7,LL)
      ATH = APH
      CTH = CPH
      XITH= XIPH
      STH = SPH
      GØ TØ 40
C     ISG1,ISG2,ISG3
   37 HØ = ST(9,LL)
   36 T = ST(8,LL)
```

```
   35 HI = ST(7,LL)
      APH = ST(2,LL)
      CPH = ST(3,LL)
      XIPH = ST(4,LL)
      SPH = ST(5,LL)
      BETTA = ST(6,LL)
      ATH = APH
      CTH = CPH
      XITH = XIPH
      STH = SPH
      GØ TØ 40
C     ST10,RWAF
C     RANKIN=THSTND MEANS INTERPØLATE,CØMPUTE NTEMP,MTEMP
C     RANKIN=NØTHRM MEANS DØ NØT INTERPØLATE,DØ NØT CØMPUTE NTEMP,NTEMP
C     RANKIN=THCNST MEANS DØ NØT AVERAGE, BUT INTERPØLATE,CØMPUTE
C                                                   NTEMP, MTEMP
C     RANKIN=THINHØ MEANS INTERPØLATE,BUT DØ NØT CØMPUTE NTEMP,MTEMP
C
  711 CØNTINUE
      XK11=ST(2,LL)
      XK12=ST(3,LL)
      XK22 = ST(4,LL)
      XK33 = ST(5,LL)
      XD11 = ST(6,LL)
      XD12 = ST(7,LL)
      XD22 = ST(8,LL)
      XD33 = ST(9,LL)
      XC11 = ST(10,LL)
      XC22 = ST(11,LL)
      XC15 = ST(12,LL)
      XC16 = ST(13,LL)
      XK21 = XK12
      XD21 = XD12
      GØ TØ 103
C
   40 CØNTINUE
      TEMP3= (1.0-XNUPT * XNUTP)
      PERM= TEMP3
      E1= (ETHET(1)+ EPHI(1))/2.
      E2= (ETHET(2)+ EPHI(2))/2.
      ES1= E1+E2
      GØ TØ (42,47,49,41),THICK
   41 GØ TØ (103,42,103,42,47,49,42,47,49,42,47,49),ISTTAB
C
C     SINGLE SHEET
C
   42 TEMP1= ETHET(1) * HI
      TEMP2= TEMP1 * HI**2
      XK11= TEMP1/TEMP3
      XD11= TEMP2/(12.0* TEMP3)
      TEMP1= EPHI(1)* HI
      TEMP2= TEMP1*HI**2
      XK22= TEMP1/TEMP3
      XD22= TEMP2/(12.0* TEMP3)
      XK33= XGPT(1)* HI
      XD33= XK33*HI**2/12.0
      GØ TØ 55
C
C     EQUAL SHEETS
C
   47 EPSUM= EPHI(1)+ EPHI(2)
```

```
      ETSUM= ETHET(1)+ ETHET(2)
      XK11= ETSUM * HI/PERM
      XK22= EPSUM * HI/PERM
      XK33= HI*(XGPT(1)+ XGPT(2))
      ZBRIN = (HI*(E1+3.0*E2)+2.0*E2*T)/(2.0*ES1)
      ZBRØUT = (HI*(E2+3.0*E1)+2.0*E1*T)/(2.0*ES1)
      ZBHIN= (ZBRIN-HI/2.0)**2
      ZBHØUT=(ZBRØUT-HI/2.0)**2
      XD33= (HI**3*(XGPT(1)+XGPT(2)))/12.0+ HI*(XGPT(1)* ZBHIN
     1      +  XGPT(2)* ZBHØUT)
      XD11=(XK11* HI**2)/12.+ HI*( ETHET(1) * ZBHIN + ETHET(2)*ZBHØUT)
     1/PERM
      XD22=(XK22* HI**2)/12.+ HI*( EPHI(1) * ZBHIN + EPHI(2)* ZBHØUT)
     1/PERM
      GØ TØ 55
C
C     UNEQUAL FACE SHEETS
C
   49 CØNTINUE
      ZBRIN =((E1*HI**2)+(E2*H0**2) +(2.0*E2*H0*HI) +(2.0*E2*H0*T)) /
     1 (2.0*(E1*HI+E2*HØ))
      ZBRØUT=((E1*HI**2)+(E2*H0**2) +(2.0*E1*H0*HI) +(2.0*E1*HI*T)) /
     1 (2.0*(E1*HI+E2*HØ))
      ZBHIN =(ZBRIN-HI/2.0)**2
      ZBHØUT =(ZBRØUT-HØ/2.0)**2
      XK11= (ETHET(1)* HI + ETHET(2)* HØ)/PERM
      XK22= (EPHI(1) * HI + EPHI(2) * HØ)/PERM
      XK33= XGPT(1)*HI + XGPT(2) * HØ
      XD33 = (XGPT(1)*HI**3+XGPT(2)*HØ**3)/12.+HI*(XGPT(1)*ZBHIN)+
     1 XGPT(2)*ZBHØUT*HØ
      D11 =  (ETHET(1)*HI**3 + ETHET(2)*HØ**3)/12.
      XD11=(D11+ (HI*ETHET(1)*ZBHIN)   + (HØ*ETHET(2)*ZBHØUT))/PERM
      D22 =  (EPHI(1)* HI**3 + EPHI(2)*HØ**3)/12.
      XD22= ( D22 +(HI*EPHI(1)*ZBHIN) + (HØ*EPHI(2)* ZBHØUT)) /PERM
C
C     DETERMINE CØMPLETE CØNSTANTS DEPENDENT ØN REINFØRCEMENT CLUE
C
   55 CØNTINUE
      IF(ISTTAB .EQ.2)GØ TØ 103
      EASTH=ER*ATH/STH
      EASPH=ES*APH/SPH
      EISPH= ES* XIPH/SPH
      EISTH= ER* XITH/STH
      GØ TØ (58,60,100),KLUE2
C
C     ST CLUE(10,11,12)
C
   58 CØNTINUE
      XK12= XK11*XNUTP
      XK11= XK11+ EASTH
      XK22= XK22+ EASPH
      XC11= EASTH*CTH
      XC22= EASPH*CPH
      XD22= - XD22 - EISPH
      XD33= XD33 + GJPH/(4.0*SPH)+ GJTH/(4.0*STH)
      XD12= -XD11*XNUTP
      XD11= -XD11- EISTH
      XK21 = XK12
      XD21 = XD12
      GØ TØ 103
C     RAF CLUE(1,2,3)
```

```
C
   60 CØNTINUE
      SINB =SIN(BETTA)
      CØSB =CØS(BETTA)
      SN2TØ4 = 2*(SINB**4.)
      D= STH*(CØSB+SINB)
      ED = ER*ATH/D
      SINB2= SINB**2.
      HL = 2.0*(ABS(ZETTA)-ABS(CTH))
      I2=(ATH**3.)/(3* HL**2)
   95 XC22 = 2.0*CTH*CØSB**3*ED
      XC15 = 2.0*CTH*CØSB*SINB2*ED
      XC16 = XC15
      GRI=  ER* I2/(2.0*(1.0 + XNUTP)*D)
      XC11 = CTH*SN2TØ4/CØSB*ED
      EDI = ER*XITH/D
      SN4TØ2 = 4.*SINB2
      XD22 = -XD22-2.0*CØSB**3*EDI-SN4TØ2*CØSB*GRI
      TB= 2.0* BETTA
      XD33 = XD33+((4.0*CØS(TB)*
     1*2*GRI)/ CØSB) + (2.0*CØSB*SINB2*EDI)
      XD12 = -XD11*XNUTP-(2.0*CØSB
     1*SINB2*EDI)-(SN4TØ2*CØSB*GRI )
      XK12= XK11*XNUTP + (2.0*CØSB*SINB2*ED)
      XK22=XK22+(2*CØSB**3*ED)
      XK33=XK33+(2*CØSB*SINB2*ED)
      XK11=XK11+(SN2TØ4*ED/CØSB)
      XD11 = -XD11-SN2TØ4*EDI/CØSB-(
     1 SN4TØ2*CØSB*GRI)
      XK21 = XK12
      XD21 = XD12
      GØ TØ 103
C
C     ISG CLUE(7,8,9)
C
  100 CØNTINUE
      SNB =SIN(BETTA)
      CSB =CØS(BETTA)
      TBETTA= 2.0*BETTA
      CS2B= CØS(TBETTA)
      ØNEC2B=(1.0+ CS2B)/2.
      SCB2  =(SNB-CS2B*SNB + 2.)/(2.0*CSB)
      SN2B  =SIN(TBETTA) /2.
      XK12=XK11*XNUTP + (EASTH*SNB*ØNEC2B/CSB)
      XK11=XK11+ EASTH*SCB2
      XK22=XK22+ EASTH*(CSB/SNB*ØNEC2B)
      XK33=XK33+ EASTH* SN2B
      XC11=      (EASTH*CTH* SCB2 )
      XC15=EASTH*CTH*( SNB* ØNEC2B/CSB )
      XC16=EASTH*CTH*SN2B
      XC22= EASTH*CTH* (CSB/SNB * ØNEC2B)
      XD12=-XD11*XNUTP- EISTH*(SNB*ØNEC2B/CSB)
      XD11=-XD11- EISTH*SCB2
      XD22 = -XD22-EISTH*(CSB/SNB*ØNEC2B)
      XD33= XD33+ EISTH*SN2B
      XK21 = XK12
      XD21 = XD12
C
C
C
  103 CØNTINUE
```

```
C                                                                         2504270
      GØ TØ (716,714,715,714),KELVIN                                      2504280
  716 TII = ST(NRW+1,LL)
      TIK = ST(NRW+2,LL)
      TØK = ST(NRW+3,LL)
      TØØ = ST(NRW+4,LL)
      GØ TØ 717
  715 TII = ST(NRW+1,LL)
      TIK = TII                                                           2504350
      TØK = TII                                                           2504360
      TØØ = TII                                                           2504370
C                                                                         2504380
  717 TEMP11= ALPHTH(1)+ XNUTP * ALPHPH(1)                                2504390
      TEMP12= ALPHTH(2)+ XNUTP * ALPHPH(2)                                2504400
      TEMP21= ALPHPH(1)+ XNUPT * ALPHTH(1)                                2504410
      TEMP22= ALPHPH(2)+ XNUPT * ALPHTH(2)                                2504420
      TEMP3 = 1-XNUPT*XNUTP                                               2504430
      TEMP4 = HI/4.0                                                      2504440
      ETHK1=  ETHET(1)*TEMP11/TEMP3                                       2504450
      TEMP5 = HI**2/24.0                                                  2504460
      ETHK2 = ETHET(2)*TEMP12/TEMP3                                       2504470
      TEMP61= TII+ TIK-2* TEFREE                                          2504480
      TEMP62= TØØ+ TØK-2* TEFREE                                          2504490
      TEMP71= 2.0* TII +TIK-3*TEFREE                                      2504500
      TEMP72= 2.0* TØØ +TØK-3*TEFREE                                      2504510
      EPHK1 = EPHI(1)*TEMP21/TEMP3                                        2504520
      EPHK2 = EPHI(2)*TEMP22/TEMP3                                        2504530
      GØ TØ (811,812,813,814),THICK                                       2504540
C                                                                         2504550
C                                                                         2504560
  811 XNTTH= ETHK1   *          TEMP4 * (TEMP61+ TEMP62)                  2504570
      XNTPH= EPHK1   *          TEMP4 * (TEMP61 + TEMP62)                 2504580
      XMTTH= ETHK1   *          TEMP5 * (TEMP71- TEMP72)                  2504590
      XMTPH= EPHK1   *          TEMP5 * (TEMP71 - TEMP72)                 2504600
      GØ TØ 714                                                           2504610
  812 TI = (HI*(E2-E1)+2.0*E2*T)/(2.0*(E1+E2))                            2504620
      TØ = (HI*(E1-E2)+2.0*E1*T)/(2.0*(E1+E2))                            2504630
      TEMP8= HI/2.0                                                       2504640
      XNTTH = ETHK1   *        TEMP8*TEMP61 + ETHK2   *       TEMP8*      2504650
     1TEMP62                                                              2504660
      XNTPH = EPHK1  *         TEMP8*TEMP61 + EPHK2   *       TEMP8*      2504670
     1TEMP62                                                              2504680
      XMTTH =(ETHK1 *  TEMP8 * (HI*TEMP71/3.0+ TI*TEMP61)) - (ETHK2 *     2504690
     1 TEMP8*(HI*TEMP72/3.0+TØ*TEMP62))                                   2504700
      XMTPH =(EPHK1 *  TEMP8 * (HI*TEMP71/3.0+ TI*TEMP61)) - (EPHK2 *     2504710
     1 TEMP8*(HI*TEMP72/3.0+TØ*TEMP62))                                   2504720
      GØ TØ 714                                                           2504730
  813 TI = (E2*HØ**2-E1*HI**2+2.0*E2*HØ*T)/(2.0*(E1*HI+E2*HØ))            2504740
      TØ = (E1*HI**2-E2*HØ**2+2.0*E1*HI*T)/(2.0*(E1*HI+E2*HØ))            2504750
      XNTTH = ETHK1*0.5*(HI*TEMP61)+ETHK2*0.5*(HØ*TEMP62)                 2504760
      XNTPH= EPHK1*0.5*(HI*TEMP61)+ EPHK2*0.5*(HØ*TEMP62)                 2504770
      XMTTH = ETHK1*0.5*(HI**2*TEMP71/3.0+TI*HI*TEMP61)-ETHK2*0.5*(HØ     2504780
     1**2*TEMP72/3.+TØ*HØ*TEMP62)                                         2504790
      XMTPH = EPHK1*0.5*(HI**2*TEMP71/3.0+TI*HI*TEMP61)-EPHK2*0.5*(HØ     2504800
     1**2*TEMP72/3.+ TØ*HØ*TEMP62)                                        2504810
      GØ TØ 714                                                           2504820
  814 TEMP10=((-XK11*XD11)**.5)/(48.0**.5)                                2504830
      TEM11 =((-XK22*XD22)**.5)/(48.0**.5)                                2504840
      XNTTH =(XK11/4.0 *TEMP11)* TEMP61 + (XK11/4.0*TEMP12) * TEMP62      2504850
      XNTPH =(XK22/4.0 *TEMP21)* TEMP61 + (XK22/4.0*TEMP22) * TEMP62      2504860
      XMTTH =  TEMP10*(TEMP11*TEMP71 - TEMP12* TEMP72)                    2504870
```

```
      XMTPH =  TEM11 *(TEMP21*TEMP71 - TEMP22* TEMP72)                  2504880
  714 CØNTINUE                                                          2504890
 8889 RETURN                                                            2504900
      END                                                               2504910
```

```
C ..... RØUTINE ** GEØMET ** ABACUS UPDATED 07/24/72 .....
      SUBRØUTINE GEØMET
C     THIS SUBRØUTINE CALCULATES THE GEØMETRY FØR A SHELL SEGMENT.
C     THE INPUT VARIABLES ARE . . .
C              RI(I) - - DISTANCE FRØM AXIS ØF REV. TØ POINTS
C                        ØN SHELL MERIDIAN.
C              ZI(I) - - DISTANCE ALØNG AXIS ØF REV. TØ THE
C                        INTERSECTIØN ØF THE CØRRESPØNDING RI(I) AND
C                        THE AXIS ØF REV.
C              NRZIN - - NUMBER ØF (RI,ZI) PAIRS READ AS INPUT.
C
      CØMMØN /SPLINS/ ANG,PSI(100),RAD(100),CUR1(100),CUR2(100),
     1        DR1DP(100),ZI(14),RI(14),NRZIN
      DIMENSIØN CI(4,13),DRDZ(14),SØUT(14),S(101),RADD(100)
C
      FUN(ARG) = SQRT(1.0 + ARG**2)
C
      RADS = 3.1415926/180.0
      DATA B/-B    -/
      AMULT = 1.0
      IF (ANG.EQ.B) AMULT = -1.0
C
C     PASS SPLINE CURVE THRØUGH INPUT PØINTS ØN SHELL MERIDIAN, AND
C     CØMPUTE DR/DZ AT THESE PØINTS.
C
      CALL PLICØ (ZI,RI,NRZIN,CI)
      NDELZ = NRZIN - 1
      DØ 60 I=1,NRZIN
      CALL PLINE (ZI,RI,NRZIN,CI,ZI(I),FAKE1,DRDZ(I),FAKE2)
   60 CØNTINUE
C
C     CØMPUTE MERIDIØNAL ARC LENGTH TØ INTERPØLATED PØINTS BY
C     NUMERICAL INTEGRATIØN (SIMPSØNS RULE).  SINCE SIMPSØNS RULE
C     REQUIRES AN EVEN NUMBER ØF PARTITIØNS, INTERPØLATE A PØINT
C     MIDWAY BETWEEN EACH PAIR ØF PØINTS USING SUBRØUTINE SPLINE.
C
      SØUT(1) = 0.
      DØ 70 I=1,NDELZ
      DZ2=(ZI(I+1)-ZI(I))/2.0
      DZ6=DZ2/3.0
      CALL PLINE (ZI,RI,NRZIN,CI,ZI(I)+DZ2,FAKE1,DRDZM,FAKE2)
      SØUT(I+1) = SØUT(I) + DZ6*(FUN(DRDZ(I)) + 4.0*FUN(DRDZM) +
     1              FUN(DRDZ(I+1)))
   70 CØNTINUE
C
C     USE SPLICØ TØ REPRESENT RI(I) AS A FUNCTIØN ØF SØUT(I).  THEN USE
C     SPLINE TØ INTERPØLATE RADD AND CØRRESPØNDING DERIVATIVES.  FRØM
C     THESE, CØMPUTE THE TWØ PRINCIPAL RADII ØF CURVATURE,
C       CUR1 = 1/R1
C       CUR2 = 1/R2
C
      ØLDH1 = SØUT(NRZIN)/99.0
      CALL PLICØ (SØUT,RI,NRZIN,CI)
      DØ 110 I=1,100
      S(I) = FLØAT(I-1)*ØLDH1
      CALL PLINE (SØUT,RI,NRZIN,CI,S(I),RAD(I),RADD(I),RADD2)
      IF (ABS(RADD(I)).GT.1.0) RADD(I)=1.0
      FACTØR = SQRT(1.0-RADD(I)**2)
      CUR1(I) = -RADD2/FACTØR
      CUR2(I) = FACTØR/RAD(I)
```

```
110 CØNTINUE
    DØ 180 J=1,100
    CØSPSI = AMULT*RADD(J)
    PSI(J) = ARCØS(CØSPSI)
    SINPSI = -AMULT*RAD(J)*CUR2(J)
    IF (ANG.EQ.B) GØ TØ 179
    PSI(J) = 2.0*3.1415926-PSI(J)
179 CØNTINUE
    CUR1(J) = -AMULT/CUR1(J)
    CUR2(J) = -AMULT/CUR2(J)
    IF (J.EQ.1) GØ TØ 180
    I = 1
    IF (J.EQ.2) GØ TØ 181
    I = 2
181 IF (ANG.EQ.B) GØ TØ 190
    DRIDP(J-1) = (CUR1(J)-CUR1(J-I))/(PSI(J)-PSI(J-I))
    GØ TØ 180
190 DRIDP(J-1) = (CUR1(J-I)-CUR1(J))/(PSI(J-I)-PSI(J))
180 CØNTINUE
    DRIDP(100) = DRIDP(99)
    DØ 42 J=1,100
    DRIDP(J) = DRIDP(J)*0.1
 42 CØNTINUE
    RETURN
    END
```

```
C ..... RØUTINE ** PLICØ  ** ABACUS UPDATED 05/20/72 .....
      SUBRØUTINE PLICØ (X,Y,M,C)
C     SUBRØUTINE TØ DETERMINE C(1,K),C(2,K),C(3,K) AND C(4,K).
      DIMENSIØN X(14),Y(14),A(14,3),B(14),Z(14)
      DIMENSIØN D(13),P(13),E(13),C(4,13)
      MM = M-1
      DØ 10 K=1,MM
      D(K) = X(K+1) - X(K)
      P(K) = D(K)/6.0
   10 E(K) = (Y(K+1)-Y(K))/D(K)
      DØ 20 K=2,MM
   20 B(K) = E(K) - E(K-1)
      A(1,2) = -1.0-D(1)/D(2)
      A(1,3) = D(1)/D(2)
      A(2,3) = P(2)-P(1)*A(1,3)
      A(2,2) = 2.0*(P(1)+P(2)) - P(1)*A(1,2)
      A(2,3) = A(2,3)/A(2,2)
      B(2) = B(2)/A(2,2)
      DØ 30 K=3,MM
      A(K,2) = 2.0*(P(K-1)+P(K))-P(K-1)*A(K-1,3)
      B(K) = B(K)-P(K-1)*B(K-1)
      A(K,3) = P(K)/A(K,2)
   30 B(K) = B(K)/A(K,2)
      Q = D(M-2)/D(M-1)
      A(M,1) = 1.0+Q+A(M-2,3)
      A(M,2) = -Q-A(M,1)*A(M-1,3)
      B(M) = B(M-2)-A(M,1)*B(M-1)
      Z(M) = B(M)/A(M,2)
      MN = M-2
      DØ 40 I=1,MN
      K = M-I
   40 Z(K) = B(K)-A(K,3)*Z(K+1)
      Z(1) = -A(1,2)*Z(2)-A(1,3)*Z(3)
      DØ 50 K=1,MM
      Q = 1.0/(6.0*D(K))
      C(1,K) = Z(K)*Q
      C(2,K) = Z(K+1)*Q
      C(3,K) = Y(K)/D(K)-Z(K)*P(K)
   50 C(4,K) = Y(K+1)/D(K)-Z(K+1)*P(K)
      RETURN
      END
```

```
C ..... RØUTINE ** PLINE  ** ABACUS UPDATED 05/20/72 .....
      SUBRØUTINE PLINE (X,Y,M,C,XINT,YINT,DYDX,D2YDX2)
C     SUBRØUTINE FØR SPLINE FIT INTERPØLATIØN IN THE TABLE ØF VALUES
C     (X1,Y1) TØ (XM,YM), WHERE M MAY BE AS LARGE AS 100, WHERE THE
C     CØNSTANTS C(1,K),C(2,K),C(3,K) AND C(4,K) ARE ALREADY CØMPUTED
C     AND STØRED.
C     SUBRØUTINE ALSØ CØMPUTES DY/DX AND D2Y/DX2 AT XINT.
      DIMENSIØN X(14),Y(14),C(4,13)
      IF (XINT-X(1)) 80,10,20
   10 YINT = Y(1)
      K=1
      GØ TØ 70
   20 K = 1
   30 IF (XINT-X(K+1)) 60,40,50
   40 YINT = Y(K+1)
      GØ TØ 70
   50 K = K + 1
      IF (M-K) 80,80,30
   60 YINT = (X(K+1) - XINT)*(C(1,K)*(X(K+1)-XINT)**2+C(3,K))
      YINT = YINT + (XINT-X(K))*(C(2,K)*(XINT-X(K))**2+C(4,K))
   70 DYDX=-3.0*(C(1,K)*(X(K+1)-XINT)**2-C(2,K)*(XINT-X(K))**2)
     1      -C(3,K)+C(4,K)
      D2YDX2=6.0*(C(1,K)*(X(K+1)-XINT)+C(2,K)*(XINT-X(K)))
      RETURN
   80 WRITE (6,90)
   90 FØRMAT (31H ØUT ØF RANGE FØR INTERPØLATIØN)
      RETURN
      END
```

SUBROUTINES DIF1 AND DIFF2

These subroutines are called in RIEMAN as necessary. DIF1 contains the differential equations for the THIC and ST clues, while DIFF2 contains the differential equations for the RWA and ISG clues. Geometry clues, trigonometric values, and predicted values of the differential equation variables are passed via label common area, EQUAZN, to subroutines DIF1 or DIFF2. The coefficients for nonlinear and load terms, X1, X2 and K, are identified depending upon the pass number and convergence criterion.

The specific derivative equations and auxiliary equations are contained in these subroutines. The values of each derivative equation, YDOT, and each auxiliary equation, YA ---, are returned to RIEMAN via label common EQUAZN.

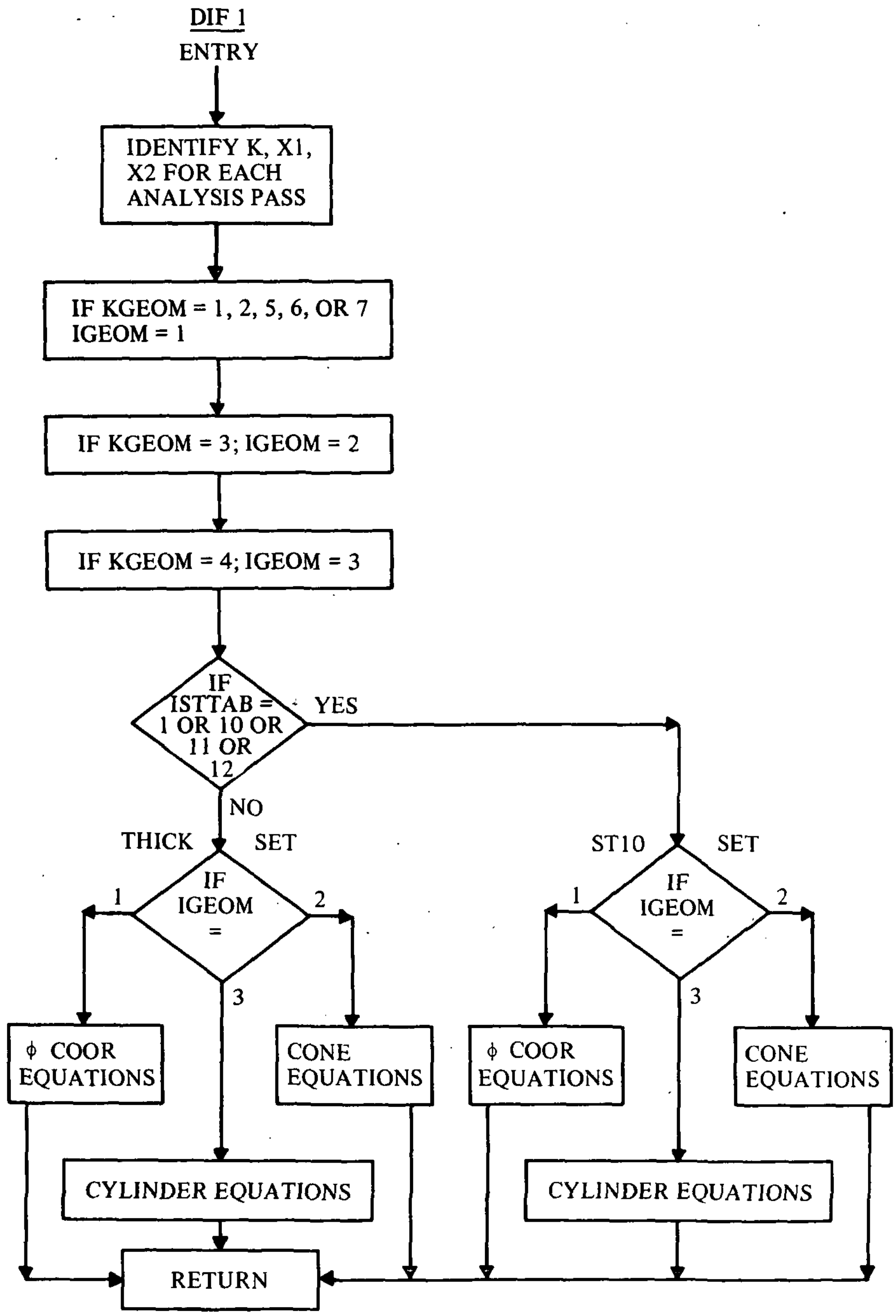
A special equation counter, I, is used in these subroutines, which counts in increments of eight. The first eight values of I, 1 through 57 (in increments of eight), correspond to the eight sets of initial conditions required to compute the segment stiffness matrices in subroutine SEGMAT. The subsequent values of I, 65 and 73 maximum (again in increments of eight) correspond to the computation of each set of eight equations for each loading condition (two conditions corresponding to dead and live loads respectively).

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1)	
XN	n	
YDOT (I)	$T_{\phi\theta,\phi}$	$\frac{dT_{\phi\theta}}{ds}$
YDOT (I + 1)	$N_{\phi,\phi}$	$\frac{dN_{\phi}}{ds}$
YDOT (I + 2)	$J_{\phi,\phi}$	$\frac{dJ_{\phi}}{ds}$
YDOT (I + 3)	$M_{\phi,\phi}$	$\frac{dM_{\phi}}{ds}$
YDOT (I + 4)	$U,_{\phi}$	$\frac{dU}{ds}$
YDOT (I + 5)	$V,_{\phi}$	$\frac{dV}{ds}$
YDOT (I + 6)	$W,_{\phi}$	$\frac{dW}{ds}$
YDOT (I + 7)	$\Omega_{\theta,\phi}$	$\frac{d\Omega_{\theta}}{ds}$
YPRED (I)	$T_{\phi\theta}$	
YPRED (I + 1)	N_{ϕ}	
YPRED (I + 2)	J_{ϕ}	
YPRED (I + 3)	M_{ϕ}	
YPRED (I + 4)	U	
YPRED (I + 5)	V	
YPRED (I + 6)	W	
YPRED (I + 7)	Ω_{θ}	
YAMPT	$M_{\phi\theta}$	
YANTH	N_{θ}	
YAMTH	M_{θ}	

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1)
R2SQ	r_2^2
ROSQ	r_0^2
X1RO	$1/r_0$
S	s
XK12	K_{12}
XK21	K_{21}
XD12	D_{12}
XD21	D_{21}
XC11	C_{11}
XC22	C_{22}
XNSQ	n^2

Non-Linear Redefinitions (Ref. 1)

YDOT (I+2)	$*J_{\phi,\phi}$	$\frac{d*J_\phi}{ds}$
YPRED (I+2)	$*J_\phi$	
YAJPH	J_ϕ	
XNL	a	
XNPHI	$\overline{N}_\phi$	



DIF 1
ENTRY
IDENTIFY K, X1, X2 FOR EACH ANALYSIS PASS
IF KGEOM = 1, 2, 5, 6, OR 7 IGEOM = 1
IF KGEOM = 3; IGEOM = 2
IF KGEOM = 4; IGEOM = 3
IF ISTTAB = 1 OR 10 OR 11 OR 12
YES
NO
THICK
SET
ST10
SET
IF IGEOM =
1
2
3
IF IGEOM =
1
2
3
ϕ COOR EQUATIONS
CONE EQUATIONS
ϕ COOR EQUATIONS
CONE EQUATIONS
CYLINDER EQUATIONS
CYLINDER EQUATIONS
RETURN

```
C ..... RØUTINE **D5      ** ABACUS UPDATED 07/07/72 .....
      SUBRØUTINE DIF1 (XFPHL1,XFZEL1,XFPHL2,XFZEL2)
      INTEGER SAVJTC,SAVSTP,Q,THICK
      INTEGER XN1,XN
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK
      DØUBLE PRECISIØN YPRED
      DØUBLE PRECISIØN YDØT,YASAVE,YANTH,YAMTH,YAMPT,YAJPH,S,SN,CS,SNSQ,
     1                 CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,X1RØ,X1RØSQ,X1SNRØ,
     2                 X1CSRØ,CN1RØ,SN1RØ,CS1RØ,X1R1,X1R2,CS1R1,CS1R2,
     3                 SN1R1,X1R1SQ,R2SQ,RØ,BESQ,RØSQ,XNSQ,R1,R2,S1,
     4                 R1DØT,XNTTH,XNTPH,XMTTH,XMTPH,XC11,XC22,XC15,
     5                 XD33,XD22,XD21,XD12,XK11,XK12,XK21,XK22,XK33,
     6                 XD11,XNPHI,BETA,XC16
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(2),NH
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS
      CØMMØN /EQUAZN/ YPRED(80),YDØT(80),YASAVE(80),
     1                YANTH,YAMTH,YAMPT,YAJPH,
     2                S,SN,CS,SNSQ,CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,
     3                X1RØ,X1RØSQ,X1SNRØ,X1CSRØ,CN1RØ,SN1RØ,CS1RØ,
     4                X1R1,X1R2,CS1R1,CS1R2,SN1R1,X1R1SQ,R2SQ,RØ,BESQ,
     5   RØSQ,XNSQ,BETA,R1,R2,S1,R1DØT,
     6                XNTTH,XNTPH,XMTTH,XMTPH,XFTHLD,XFPHLD,XFZELD,
     7  XMTHLD,XMPHLD,ETHET(2),EPHI(2),XGPT(2),ALPHTH(2),ALPHPH(2),DUM,
     8                XNUTP,XNUPT,XC11,XC22,XC15,XD33,XD22,XD21,XD12,
     9                XK11,XK12,XK21,XK22,XK33,XD11,
     A   XNPHI,M,I,BETTA,ZETTA,SAVY(8),XC16
      EQUIVALENCE (XNL(1),X1),(XNL(2),X2)
C     IF (NH.NE.0) WRITE(6,1333) PHI,SAVY
 1333 FØRMAT(1X,1P1E16.7,5X,1P6E16.7)
      IGEØM = 0
      IF (KGEØM.EQ.1.ØR.KGEØM.EQ.2.ØR.KGEØM.EQ.5.ØR.KGEØM.EQ.6) IGEØM =1
      IF (KGEØM.EQ.3) IGEØM=2
      IF(KGEØM.EQ.4) IGEØM=3
      IF ( KGEØM.EQ.7 ) IGEØM = 1
      K = 0
      IF (KBC.EQ.0.AND.NH.EQ.0) K = 1
      IF(ISTTAB.EQ.1)  GØ TØ 7786
      IF(ISTTAB.GE.10)GØ TØ 7786
C     THE FØLLØWING EQUATIØNS ARE THE -THICK- SET
      GØ TØ (151,152,153),IGEØM
C   EQUATIØNS FØR SHELLS ØF REVØLUTIØN  ( PHI  CØØRDINATE )
  151 YANTH      = XNUPT*YPRED(I+1)+(XK11-XNUPT**2*XK22)*(XN*YPRED(I+4)+
     1             YPRED(I+5)*CS-YPRED(I+6)*SN)*X1RØ+K*(XNUPT*XNTPH-
     2             XNTTH)
      YAMTH      = XNUPT*YPRED(I+3)-(XD11-XNUPT**2*XD22)*X1RØ*(X1RØ*(XN*
     1             YPRED(I+4)*SN-XNSQ*YPRED(I+6))+YPRED(I+7)*CS)+K*
     2             (XNUPT*XMTPH-XMTTH)
      YAØPH      = XN*YPRED(I+6)*X1RØ-YPRED(I+4)*SN1RØ
      YAMPT      = (-1.0/((RØ/XD33)+(SNSQ*X1RØ/XK33)))*(-2.0*XN*
     1             YPRED(I+7)+YPRED(I+4)*(CS1R1-CN1RØ)+XN*YPRED(I+5)*
     2             (SN1RØ+X1R1)+2.0*XN*YPRED(I+6)*CS1RØ+YPRED(I)*SN/
     3             XK33+SN*YAØPH*(X1*SAVY(3)+X2*SAVY(6)))
      YAJPH      = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
     1             -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT      = YPRED(I)+YAMPT*SN1RØ
```

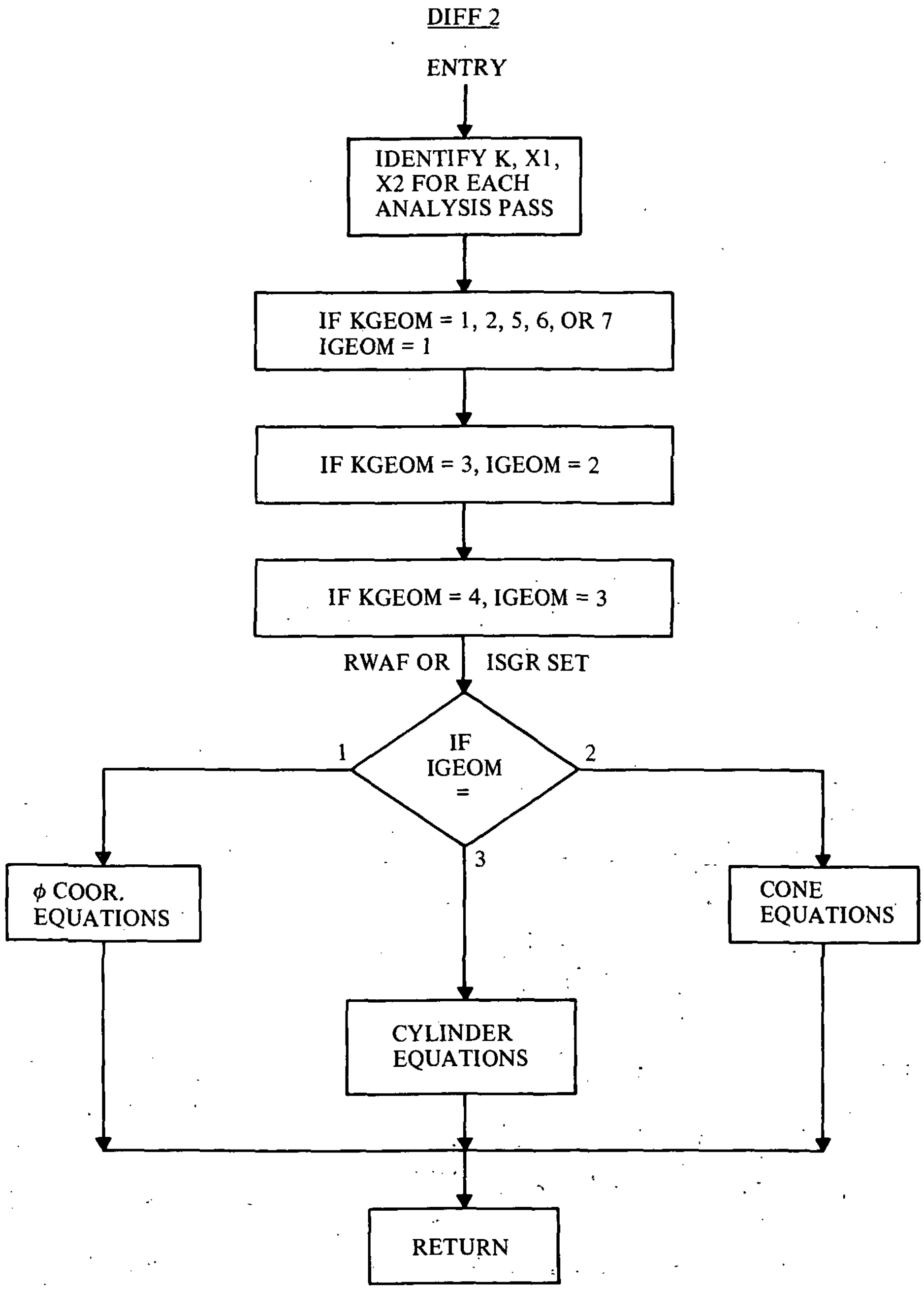
```
      YDØT(I+4)  = R1*(YPRED(I+4)*CS1RØ+XN*YPRED(I+5)*X1RØ+YPRED(I)/XK33+
     1             YAMPT*SN1RØ/XK33)+R1*YAØPH*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I)    = R1*(-2.0*YPRED(I)*CS1RØ+XN*YANTH*X1RØ-XN*YAMTH*SN*
     1             X1RØSQ-YAMPT*CS1RØ*(X1R1-SN1RØ))-R1*K*(XFTHLD+XMPHLD*
     2             SN1RØ)-(YDØT(I+4)*(X1*XFPHL1+X2*XFPHL2)+R1*YAØPH*
     3             (X1*XFZEL1+X2*XFZEL2))-R1*SN1RØ*(YAØPH*(X1*SAVY(1)+
     4             X2*SAVY(4))-YANPT*(X1*SAVY(3)+X2*SAVY(6)))
      YDØT(I+5)  = R1*(YPRED(I+6)*X1R1+(1.0/(XK22-XNUTP**2*XK11))*
     1             (YPRED(I+1)-XNUTP*YANTH+K*(XNTPH-XNUTP*XNTTH)))
     2             -R1*YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
      EPSITH     = X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)
      EPSIPH     = X1R1*(YDØT(I+5)-YPRED(I+6))+YPRED(I+7)*(X1*SAVY(3)+
     1             X2*SAVY(6))
      YDØT(I+1)  = R1*(CS1RØ*(YANTH-YPRED(I+1))-XN*X1RØ*(YPRED(I)+
     1             YAMPT*(SN*X1RØ+X1R1))+YPRED(I+2)*X1R1)-R1*K*XFPHLD
     2             -R1*((EPSITH+EPSIPH)*(X1*XFPHL1+X2*XFPHL2)-YPRED(I+7)*
     3             (X1*XFZEL1+X2*XFZEL2))
      YDØT(I+2)  = R1*(-YPRED(I+2)*CS1RØ-YANTH*SN1RØ-YPRED(I+1)*X1R1
     1             +XNSQ*YAMTH*X1RØSQ-2.0*XN*YAMPT*CS*X1RØSQ)+R1*K*
     2             (XN*XMPHLD*X1RØ-XFZELD)-R1*((EPSITH+EPSIPH)*(X1*
     3             XFZEL1+X2*XFZEL2)+YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2))
     4             -R1*X1RØ*XN*(YANPT*(X1*SAVY(3)+X2*SAVY(6))-YAØPH*
     5             (X1*SAVY(1)+X2*SAVY(4)))
      YDØT(I+3)  = R1*(YAMTH*CS1RØ-YPRED(I+3)*CS1RØ-2.0*XN*YAMPT*X1RØ+
     1             YAJPH+K*XMTHLD)
      YDØT(I+6)  = R1*(YPRED(I+7)-YPRED(I+5)*X1R1)
      YDØT(I+7)  = R1*(1.0/(XD22-XNUTP**2*XD11))*(-YPRED(I+3)+XNUTP*
     1             YAMTH-K*(XMTPH-XNUTP*XMTTH))
      GØTØ 9005
C     EQUATIØNS FØR CØNE
  152 YANTH=XNUPT*YPRED(I+1)+(XK11-XNUPT**2*XK22)*(X1CS/S)*(XN*YPRED(I+4
     1             )+YPRED(I+5)*CS-YPRED(I+6)*SN)+K*(XNUPT*XNTPH-XNTTH)
      YAMTH=XNUPT*YPRED(I+3)-(1.0/S)*X1CS*(XD11-XNUPT**2*XD22)*((1.0/S)*
     1       X1CS*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+YPRED(I+7)*CS)-
     2             K*(XMTTH-XNUPT*XMTPH)
      YAØPH      = XN*YPRED(I+6)*X1CS/S-YPRED(I+4)*TAN/S
      YAMPT=(-1.0/((S*CS/XD33)+(SN*TN/(XK33*S))))*(-2.0*XN*YPRED(I+7)-
     1       YPRED(I+4)*SN/S+XN*YPRED(I+5)*TN/S+2.0*XN*YPRED(I+6)/S+YPRED
     2             (I)*SN/XK33+SN*YAØPH*(X1*SAVY(3)+X2*SAVY(6)))
      YAJPH      = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
     1             -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT      = YPRED(I)+YAMPT*TAN/S
      YDØT(I+4)=(1.0/S)*(YPRED(I+4)+XN*YPRED(I+5)*X1CS+YAMPT*TN/XK33)
     1             +YPRED(I)/XK33+YAØPH*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I)   =-2.0*YPRED(I)/S+XN*YANTH*X1CS/S-XN*YAMTH*SN*X1CS**2/S**2
     1             +YAMPT*TAN/S**2-K*(XFTHLD+XMPHLD*TAN/S)-(YDØT(I+4)*
     2             (X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+X2*XFZEL2))-
     3             TAN/S*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*(X1*SAVY(3)
     4             +X2*SAVY(6)))
      YD2T(I+5)  = (1.0/(XK22-XNUTP**2*XK11))*(YPRED(I+1)-XNUTP*YANTH+
     1             K*(XNTPH-XNUTP*XNTTH))-YPRED(I+7)*(X1*SAVY(3)+X2*
     2             SAVY(6))
      EPSITH     = (1.0/(S*CS))*(XN*YPRED(I+4)+CS*YPRED(I+5)-SN*
     1             YPRED(I+6))
      EPSIPH     = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I+1)= -YPRED(I+1)/S+YANTH/S-XN*YPRED(I)/(S*CS)-XN*YAMPT*SN/
     1             (S**2*CS**2)-K*XFPHLD-(EPSITH+EPSIPH)*(X1*XFPHL1+X2*
     2             XFPHL2)+YPRED(I+7)*(X1*XFZEL1+X2*XFZEL2)
      YDØT(I±2)  = -YPRED(I+2)/S-YANTH*TAN/S+XNSQ*YAMTH/(S**2*CS**2)
     1             -2.0*XN*YAMPT/(S**2*CS)+K*(XN*XMPHLD*X1CS/S-XFZELD)
     2             -(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-YPRED(I+7)*
```

```
     3           (X1*XFPHL1+X2*XFPHL2)-X1CS/S*XN*(YANPT*(X1*SAVY(3)+
     4           X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))
      YDØT(I+3)= YAMTH/S-YPRED(I+3)/S-2.0*XN*YAMPT/(S*CS)+YAJPH+XMTHLD
     1           *K
      YDØT(I+6)=YPRED(I+7)
      YDØT(I+7)=(1.0/(XD22-XNUTP**2*XD11))*(-YPRED(I+3)+XNUTP*YAMTH-
     1           K*(XMTPH-XNUTP*XMTTH))
      GØ TØ 9005
C     EQUATIØNS FØR CYLINDER
  153 YANTH=XNUPT*YPRED(I+1)+(XK11-XNUPT**2*XK22)*(X1RØ*(XN*YPRED(I+4)-
     1           YPRED(I+6)))+K*(XNUPT*XNTPH-XNTTH)
      YAMTH=XNUPT*YPRED(I+3)-(X1RØ*(XD11-XNUPT**2*XD22))*(X1RØ*(XN*YPRED
     1           (I+4)-XNSQ*YPRED(I+6)))+K*(XNUPT*XMTPH-XMTTH)
      YAØPH      = X1RØ*(XN*YPRED(I+6)-YPRED(I+4))
      YAMPT=(-1.0/((RØ/XD33)+(X1RØ/XK33)))*(-2.0*XN*YPRED(I+7)+XN*X1RØ*
     1           YPRED(I+5)+YPRED(I)/XK33+YAØPH*(X1*SAVY(3)+X2*
     2           SAVY(6)))
      YAJPH      = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
     1           -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT      = YPRED(I)+YAMPT*X1RØ
      YDØT(I+4)=XN*YPRED(I+5)*X1RØ+YPRED(I)/XK33+YAMPT*X1RØ/XK33
     1           +YAØPH*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I)    = XN*YANTH*X1RØ-XN*YAMTH*X1RØSQ-K*(XFTHLD+XMPHLD*X1RØ)
     1           -(YDØT(I+4)*(X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+
     2           X2*XFZEL2))-X1RØ*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*
     3           (X1*SAVY(3)+X2*SAVY(6)))
      YDØT(I+5)  = (1.0/(XK22-XNUTP**2*XK11))*(YPRED(I+1)-XNUTP*YANTH+
     1           K*(XNTPH-XNUTP*XNTTH))-YPRED(I+7)*(X1*SAVY(3)+X2*
     2           SAVY(6))
      EPSITH     = X1RØ*(XN*YPRED(I+4)-YPRED(I+6))
      EPSIPH     = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I+1)  = -XN*X1RØ*YPRED(I)-XN*YAMPT*X1RØSQ-K*XFPHLD-(EPSITH+
     1           EPSIPH)*(X1*XFPHL1+X2*XFPHL2)+YPRED(I+7)*(X1*XFZEL1+
     2           X2*XFZEL2)
      YDØT(I+2)  = -YANTH*X1RØ+XNSQ*YAMTH*X1RØSQ+K*(XN*XMPHLD*X1RØ-
     1           XFZELD)-(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-
     2           YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2)-X1RØ*XN*(YANPT*
     3           (X1*SAVY(3)+X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))
      YDØT(I+3)  = -2.0*XN*YAMPT*X1RØ+YAJPH+K*XMTHLD
      YDØT(I+6)=YPRED(I+7)
      YDØT(I+7)  = (1.0/(XD22-XNUTP**2*XD11))*(-YPRED(I+3)+XNUTP*YAMTH+
     1           K*(XNUTP*XMTTH-XMTPH))
      GØ TØ 9005
 7786 GØ TØ (4771,4772,4773),IGEØM
C     THE FØLLØWING EQUATIØNS ARE THE -ST10- SET
C     EQUATIØNS FØR SHELLS ØF REVØLUTIØN  ( PHI  CØØRDINATE )
 4771 YANTH      = XK12*(1.0/(XK22+XC22**2/XD22))*(YPRED(I+1)+K*XNTPH+
     1           (XC22/XD22)*(YPRED(I+3)+K*XMTPH))-K*XNTTH+(X1RØ*XK11-
     1           XK12*XK21*X1RØ*(1.0/
     2        (XK22+XC22**2/XD22)))*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+
     3       6)*SN)-(XC11+XK12*XC22*XD21/XD22*(1.0/(XK22+XC22**2/XD22)))*
     4        (X1RØ**2*(XN*YPRED(I+4)*SN-XN**2*YPRED(I+6))+YPRED(I+7)*CS*
     5        X1RØ)
      YAMTH      = -XD12*(XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH)
     1           -K*XMTTH+XD12*(XK22/(XC22**2+XK22*XD22))*(YPRED(I+3)+
     1           K*XMTPH)+(XC11*
     2        X1RØ+XD12*XK21*X1RØ*(XC22/(XC22**2+XK22*XD22)))*(XN*YPRED(
     3        I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)+(XD11-XD12*XK22*XD21/(
     4        XC22**2+XK22*XD22))*(X1RØSQ*(XN*YPRED(I+4)*SN-XNSQ*YPRED
     5        (I+6))+YPRED(I+7)*CS*X1RØ)
      YAØPH      = XN*YPRED(I+6)*X1RØ-YPRED(I+4)*SN1RØ
```

```
      YAMPT     = (-1.0/((RØ/XD33)+(SNSQ*X1RØ/XK33)))*(-2.0*XN*
     1            YPRED(I+7)+YPRED(I+4)*(CS1R1-CN1RØ)+XN*YPRED(I+5)*
     2            (SN1RØ+X1R1)+2.0*XN*YPRED(I+6)*CS1RØ+YPRED(I)*SN/
     3            XK33+SN*YAØPH*(X1*SAVY(3)+X2*SAVY(6)))
      YAJPH     = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
     1            -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT     = YPRED(I)+YAMPT*SN1RØ
      YDØT(I+4) = R1*(YPRED(I+4)*CS1RØ+XN*YPRED(I+5)*X1RØ+YPRED(I)/XK33+
     1            YAMPT*SN1RØ/XK33)+R1*YAØPH*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I)   = R1*(-2.0*YPRED(I)*CS1RØ+XN*YANTH*X1RØ-XN*YAMTH*SN*
     1            X1RØSQ-YAMPT*CS1RØ*(X1R1-SN1RØ))-R1*K*(XFTHLD+XMPHLD*
     2            SN1RØ)-(YDØT(I+4)*(X1*XFPHL1+X2*XFPHL2)+R1*YAØPH*
     3            (X1*XFZEL1+X2*XFZEL2))-R1*SN1RØ*(YAØPH*(X1*SAVY(1)+
     4            X2*SAVY(4))-YANPT*(X1*SAVY(3)+X2*SAVY(6)))
      YDØT(I+5) = R1*(YPRED(I+6)*X1R1-YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
     1            +(1.0/(XK22+XC22**2/XD22))*(YPRED(I+1)+K*XNTPH+(XC22/
     1            XD22)*(YPRED(I+3)+K*XMTPH)-XK21*X1RØ*(XN*
     2           YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)-(XC22*XD21/XD22
     3           )*(X1RØSQ*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+YPRED(I+7)
     4           *CS*X1RØ)))
      EPSITH    = X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)
      EPSIPH    = X1R1*(YDØT(I+5)-YPRED(I+6))+YPRED(I+7)*(X1*SAVY(3)+
     1            X2*SAVY(6))
      YDØT(I+1) = R1*(CS1RØ*(YANTH-YPRED(I+1))-XN*X1RØ*(YPRED(I)+
     1            YAMPT*(SN*X1RØ+X1R1))+YPRED(I+2)*X1R1)-R1*K*XFPHLD
     2            -R1*((EPSITH+EPSIPH)*(X1*XFPHL1+X2*XFPHL2)-YPRED(I+7)*
     3            (X1*XFZEL1+X2*XFZEL2))
      YDØT(I+2) = R1*(-YPRED(I+2)*CS1RØ-YANTH*SN1RØ-YPRED(I+1)*X1R1
     1            +XNSQ*YAMTH*X1RØSQ-2.0*XN*YAMPT*CS*X1RØSQ)+R1*K*
     2            (XN*XMPHLD*X1RØ-XFZELD)-R1*((EPSITH+EPSIPH)*(X1*
     3            XFZEL1+X2*XFZEL2)+YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2))
     4            -R1*X1RØ*XN*(YANPT*(X1*SAVY(3)+X2*SAVY(6))-YAØPH*
     5            (X1*SAVY(1)+X2*SAVY(4)))
      YDØT(I+3) = R1*(YAMTH*CS1RØ-YPRED(I+3)*CS1RØ-2.0*XN*YAMPT*X1RØ+
     1            YAJPH+K*XMTHLD)
      YDØT(I+6) = R1*(YPRED(I+7)-YPRED(I+5)*X1R1)
      YDØT(I+7) = R1*((-XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH-
     1            (XK21/
     1          RØ)*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN))
     2          +(XK22/(XC22**2+XK22*XD22))*(YPRED(I+3)+K*XMTPH)-(XK22*
     3          XD21/(XC22**2+XK22*XD22))*(X1RØSQ*(XN*YPRED(I+4)*SN-XNSQ
     4          *YPRED(I+6))+YPRED(I+7)*CS*X1RØ))
      GØ TØ 9005
C     EQUATIØNS FØR CØNE
 4772 YANTH     = XK12*(1.0/(XK22+XC22**2/XD22))*(YPRED(I+1)+K*XNTPH+
     1            (XC22/XD22)*(YPRED(I+3)+K*XMTPH))-K*XNTTH+(1.0/(CS*S))
     1            *(XK11-XK12*XK21*(
     2       1.0/(XK22+XC22**2/XD22)))*(XN*YPRED(I+4)+YPRED(I+5)*CS-
     3       YPRED(I+6)*SN)-(XC11+(XK12*XD21*XC22/XD22)*(1.0/(XK22+XC22*
     4       *2/XD22)))*((1.0/(S**2*CS**2))*(XN*YPRED(I+4)*SN-XNSQ*YPRED
     5       (I+6))+YPRED(I+7)/S)
      YAMTH     = -XD12*(XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH)
     1            -K*XMTTH+XD12*(XK22/(XC22**2+XK22*XD22))*(YPRED(I+3)+
     1            K*XMTPH)+(XC11/
     2        (S*CS)+XD12*XK21/(S*CS))*(XC22/(XC22**2+XK22*XD22))*(XN*
     3        YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)+(XD11-XD12*XK22*
     4        XD21/(XC22**2+XK22*XD22))*((1.0/(S*CS)**2)*(XN*YPRED(I+4)*
     5        SN-XNSQ*YPRED(I+6))+YPRED(I+7)/S)
      YAØPH     = XN*YPRED(I+6)*X1CS/S-YPRED(I+4)*TAN/S
      YAMPT=(-1.0/((S*CS/XD33)+(SN*TN/(XK33*S))))*(-2.0*XN*YPRED(I+7)-
     1     YPRED(I+4)*SN/S+XN*YPRED(I+5)*TN/S+2.0*XN*YPRED(I+6)/S+YPRED
```

```
2             (I)*SN/XK33+SN*YAØPH*(X1*SAVY(3)+X2*SAVY(6)))
      YAJPH      = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
1                -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT      = YPRED(I)+YAMPT*TAN/S
      YDØT(I+4)=(1.0/S)*(YPRED(I+4)+XN*YPRED(I+5)*X1CS+YAMPT*TN/XK33)
1                +YPRED(I)/XK33+YAØPH*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I)   =-2.0*YPRED(I)/S+XN*YANTH*X1CS/S-XN*YAMTH*SN*X1CS**2/S**2
1                +YAMPT*TAN/S**2-K*(XFTHLD+XMPHLD*TAN/S)-(YDØT(I+4)*
2                (X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+X2*XFZEL2))-
3                TAN/S*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*(X1*SAVY(3)
4                +X2*SAVY(6)))
      YDØT(I+5) = -YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))+(1.0/(XK22+XC22**2
1                /XD22))*(YPRED(I+1)+K*XNTPH+(XC22/XD22)*(YPRED(I+3)
1                +K*XMTPH)-(XK21/(S*CS))*(XN*YPRED(I+4)+YPRED(
2              I+5)*CS-YPRED(I+6)*SN)-(XC22*XD21/XD22)*((1.0/(S**2*CS**
3              2))*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+YPRED(I+7)/S))
      EPSITH     = (1.0/(S*CS))*(XN*YPRED(I+4)+CS*YPRED(I+5)-SN*
1                YPRED(I+6))
      EPSIPH     = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I+1)= -YPRED(I+1)/S+YANTH/S-XN*YPRED(I)/(S*CS)-XN*YAMPT*SN/
1                (S**2*CS**2)-K*XFPHLD-(EPSITH+EPSIPH)*(X1*XFPHL1+X2*
2                XFPHL2)+YPRED(I+7)*(X1*XFZEL1+X2*XFZEL2)
      YDØT(I+2) = -YPRED(I+2)/S-YANTH*TAN/S+XNSQ*YAMTH/(S**2*CS**2)
1                -2.0*XN*YAMPT/(S**2*CS)+K*(XN*XMPHLD*X1CS/S-XFZELD)
2                -(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-YPRED(I+7)*
3                (X1*XFPHL1+X2*XFPHL2)-X1CS/S*XN*(YANPT*(X1*SAVY(3)+
4                X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))
      YDØT(I+3)= YAMTH/S-YPRED(I+3)/S-2.0*XN*YAMPT/(S*CS)+YAJPH+XMTHLD
1                *K
      YDØT(I+6)=YPRED(I+7)
      YDØT(I+7) = -(XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH-XK21*
1                (XN*
1              YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)/(S*CS))
2              +(XK22/(XC22**2+XK22*XD22))*(YPRED(I+3)+K*XMTPH)-(XK22*
1              XD21
3              /(XC22**2+XK22*XD22))*((1.0/(S*CS)**2)*(XN*YPRED(I+4)*SN
4              -XN**2*YPRED(I+6))+YPRED(I+7)/S)
      GØ TØ 9005
C     EQUATIØNS FØR CYLINDER
 4773 YANTH      = XK12*(1.0/(XK22+XC22**2/XD22))*(YPRED(I+1)+K*XNTPH+
1                (XC22/XD22)*(YPRED(I+3)+K*XMTPH))-K*XNTTH+(X1RØ*(XK11-
1                XK12*XK21*(1.0/(
2            XK22+XC22**2/XD22))))*(XN*YPRED(I+4)-YPRED(I+6))-(XC11+(
3            XK12*XC22*XD21/XD22)*(1.0/(XK22+XC22**2/XD22)))*(X1RØ**2*(
4            XN*YPRED(I+4)-XNSQ*YPRED(I+6)))
      YAMTH      = -XD12*(XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH)
1                -K*XMTTH+XD12*(XK22/(XC22**2+XK22*XD22))*(YPRED(I+3)+
1                K*XMTPH)+(XC11*
2             X1RØ+XD12*XK21*X1RØ*(XC22/(XC22**2+XK22*XD22)))*(XN*YPRED
3             (I+4)-YPRED(I+6))+(XD11-XD12*XK22*XD21/(XC22**2+XK22*XD22)
4             )*(X1RØSQ*(XN*YPRED(I+4)-XNSQ*YPRED(I+6)))
      YAØPH      = X1RØ*(XN*YPRED(I+6)-YPRED(I+4))
      YAMPT=(-1.0/((RØ/XD33)+(X1RØ/XK33)))*(-2.0*XN*YPRED(I+7)+XN*X1RØ*
1                YPRED(I+5)+YPRED(I)/XK33+YAØPH*(X1*SAVY(3)+X2*
2                SAVY(6)))
      YAJPH      = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
1                -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT      = YPRED(I)+YAMPT*X1RØ
      YDØT(I+4)=XN*YPRED(I+5)*X1RØ+YPRED(I)/XK33+YAMPT*X1RØ/XK33
1                +YAØPH*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I)    = XN*YANTH*X1RØ-XN*YAMTH*X1RØSQ-K*(XFTHLD+XMPHLD*X1RØ)
```

```
1              -(YDØT(I+4)*(X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+
2              X2*XFZEL2))-X1RØ*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*
3              (X1*SAVY(3)+X2*SAVY(6)))
 YDØT(I+5) = -YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))+(1.0/(XK22+XC22**2
1              /XD22))*(YPRED(I+1)+K*XNTPH+(XC22/XD22)*(YPRED(I+3)
1              +K*XMTPH)-(XK21*X1RØ)*(XN*YPRED(I+4)-YPRED
2        (I+6))-(XC22*XD21/XD22)*(X1RØSQ*(XN*(YPRED(I+4)-XN*YPRE
3              D(I+6)))))
 EPSITH    = X1RØ*(XN*YPRED(I+4)-YPRED(I+6))
 EPSIPH    = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
 YDØT(I+1) = -XN*X1RØ*YPRED(I)-XN*YAMPT*X1RØSQ-K*XFPHLD-(EPSITH+
1              EPSIPH)*(X1*XFPHL1+X2*XFPHL2)+YPRED(I+7)*(X1*XFZEL1+
2              X2*XFZEL2)
 YDØT(I+2) = -YANTH*X1RØ+XNSQ*YAMTH*X1RØSQ+K*(XN*XMPHLD*X1RØ-
1              XFZELD)-(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-
2              YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2)-X1RØ*XN*(YANPT*
3              (X1*SAVY(3)+X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))
 YDØT(I+3) = -2.0*XN*YAMPT*X1RØ+YAJPH+K*XMTHLD
 YDØT(I+6)=YPRED(I+7)
 YDØT(I+7) = -(XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH-XK21*
1              X1RØ*(
1            XN*YPRED(I+4)-YPRED(I+6)))+(XK22/(XC22**2+XK22*XD22))*(
2              YPRED(I+3)+K*XMTPH)-(XK22*XD21/(XC22**2+XK22*XD22))*(
3            X1RØSQ*(XN*YPRED(I+4)-XNSQ*YPRED(I+6)))
9005 CØNTINUE
 RETURN
  END
```


DIFF 2
ENTRY
IDENTIFY K, X1, X2 FOR EACH ANALYSIS PASS
IF KGEOM = 1, 2, 5, 6, OR 7 IGEOM = 1
IF KGEOM = 3, IGEOM = 2
IF KGEOM = 4, IGEOM = 3
RWAF OR ISGR SET
IF IGEOM =
1
2
3
ϕ COOR. EQUATIONS
CONE EQUATIONS
CYLINDER EQUATIONS
RETURN

```
C ..... RØUTINE **D6       ** ABACUS UPDATED 07/07/72 .....
      SUBRØUTINE DIFF2 (XFPHL1,XFZEL1,XFPHL2,XFZEL2)
      INTEGER SAVJTC,SAVSTP,Q,THICK
      INTEGER XN1,XN
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK
      DØUBLE PRECISIØN YPRED
      DØUBLE PRECISIØN YDØT,YASAVE,YANTH,YAMTH,YAMPT,YAJPH,S,SN,CS,SNSQ,
     1                 CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,X1RØ,X1RØSQ,X1SNRØ,
     2                 X1CSRØ,CN1RØ,SN1RØ,CS1RØ,X1R1,X1R2,CS1R1,CS1R2,
     3                 SN1R1,X1R1SQ,R2SQ,RØ,BESQ,RØSQ,XNSQ,R1,R2,S1,
     4                 R1DØT,XNTTH,XNTPH,XMTTH,XMTPH,XC11,XC22,XC15,
     5                 XD33,XD22,XD21,XD12,XK11,XK12,XK21,XK22,XK33,
     6                 XD11,XNPHI,BETA,XC16
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(2),NH
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS
      CØMMØN /EQUAZN/ YPRED(80),YDØT(80),YASAVE(80),
     1                YANTH,YAMTH,YAMPT,YAJPH,
     2                S,SN,CS,SNSQ,CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,
     3                X1RØ,X1RØSQ,X1SNRØ,X1CSRØ,CN1RØ,SN1RØ,CS1RØ,
     4                X1R1,X1R2,CS1R1,CS1R2,SN1R1,X1R1SQ,R2SQ,RØ,BESQ,
     5    RØSQ,XNSQ,BETA,R1,R2,S1,R1DØT,
     6                XNTTH,XNTPH,XMTTH,XMTPH,XFTHLD,XFPHLD,XFZELD,
     7  XMTHLD,XMPHLD,ETHET(2),EPHI(2),XGPT(2),ALPHTH(2),ALPHPH(2),DUM,
     8                XNUTP,XNUPT,XC11,XC22,XC15,XD33,XD22,XD21,XD12,
     9                XK11,XK12,XK21,XK22,XK33,XD11,
     A                XNPHI,M,I,BETTA,ZETTA,SAVY(8),XC16
      EQUIVALENCE (XNL(1),X1),(XNL(2),X2)
      IGEØM = 0
      IF (KGEØM.EQ.1.ØR.KGEØM.EQ.2.ØR.KGEØM.EQ.5.ØR.KGEØM.EQ.6) IGEØM =1
      IF (KGEØM.EQ.3) IGEØM=2
      IF(KGEØM.EQ.4) IGEØM=3
      IF ( KGEØM.EQ.7 ) IGEØM = 1
      K = 0
      IF (KBC.EQ.0.AND.NH.EQ.0) K = 1
 7447 GØ TØ (7341,7342,7343),IGEØM
C     THE FØLLØWING EQUATIØNS ARE THE -RWAF- SET
C     EQUATIØNS FØR SHELLS ØF REVØLUTIØN ( PHI CØØRDINATE )
 7341 YANTH     = (YPRED(I+1)+K*XNTPH)*(XC15*XC22+XD22*XK12)/(XK22*XD22+
     1 XC22**2)-K*XNTTH+(XK12*XC22-XK22*XC15)*(YPRED(I+3)+K*XMTPH)/
     2 (XC22*XC22+XK22*XD22)+X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-
     3 YPRED(I+6)*SN)*(XK11+(XC15*(XC15*XK22-2.0*XK12*XC22)-XK12*XK12*
     4 XD22)/(XK22*XD22+XC22*XC22))+(X1RØSQ*(XN*YPRED(I+4)*SN-XNSQ
     5 *YPRED(I+6))+X1RØ*YPRED(I+7)*CS)*(-XC11+(XC15*XC15*XC22+
     6 XC15*(XK12*XD22+XK22*XD12)-XK12*XD12*XC22)/(XK22*XD22+XC22*XC22))
      YAMTH     = (YPRED(I+3)+K*XMTPH)*(XC15*XC22+XK22*XD12)/(XK22*XD22+
     1 XC22*XC22)+(YPRED(I+1)+K*XNTPH)*(XD22*XC15-XD12*XC22)/(XD22*XK22+
     2 XC22**2)-K*XMTTH+(X1RØSQ*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+
     3 X1RØ*YPRED(I+7)*CS)*(XD11-(XD12*XD12*XK22+XC15*(2.0*XC22*XD12-
     3 XC15*
     4 XD22))/(XC22*XC22+XK22*XD22))+X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-
     5 YPRED(I+6)*SN)*(XC11+(XD12*XC22*XK12-XC15*(XC15*XC22+XD12*XK22+
     6 XD22*XK12))/(XC22*XC22+XK22*XD22))
      YAØPH     = XN*YPRED(I+6)*X1RØ-YPRED(I+4)*SN1RØ
      YAMPT = (1.0/(XC16*SN*X1RØ-XK33-SN*X1RØ*(XD33*SN/(      RØ)-XC16)))
     1       *((XK33*XD33-XC16**2)*X1RØ*(-2.0*XN*YPRED(I+7)+YPRED(I+4)*
```

```
 2           (CS*X1R1-CN1RØ)+XN*YPRED(I+5)*(X1R1+SN1RØ)+2.0*XN*YPRED
 3           (I+6)*CS*X1RØ)+YAØPH*SN*(X1*SAVY(3)+X2*SAVY(6))+YPRED(I)*
 4           (XD33*SN*X1RØ-XC16))
  YAJPH       = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
 1              -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
  YANPT       = YPRED(I)+YAMPT*SN1RØ
  YDØT(I+4)   = R1*(YPRED(I+4)*CS*X1RØ+YAØPH*(X1*SAVY(3)+X2*SAVY(6))
 1              +XN*YPRED(I+5)*X1RØ+(1.0/(XK33-
 1             XC16**2/XD33))*(YPRED(I)+YAMPT*(SN*X1RØ-XC16/XD33)))
  YDØT(I)     = R1*(-2.0*YPRED(I)*CS1RØ+XN*YANTH*X1RØ-XN*YAMTH*SN*
 1              X1RØSQ-YAMPT*CS1RØ*(X1R1-SN1RØ))-R1*K*(XFTHLD+XMPHLD*
 2              SN1RØ)-(YDØT(I+4)*(X1*XFPHL1+X2*XFPHL2)+R1*YAØPH*
 3              (X1*XFZEL1+X2*XFZEL2))-R1*SN1RØ*(YAØPH*(X1*SAVY(1)+
 4              X2*SAVY(4))-YANPT*(X1*SAVY(3)+X2*SAVY(6)))
  YDØT(I+5)   = YPRED(I+6)-R1*YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))+R1*
 1              (XD22*(YPRED(I+1)+K*XNTPH)+XC22*(YPRED(I+3)+K*XMTPH)-
 2              X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)*
 3              (XK12*XD22+XC15*XC22)-(X1RØSQ*(XN*YPRED(I+4)-XNSQ*
 4              YPRED(I+6))+X1RØ*YPRED(I+7)*CS)*(XC22*XD12-XC15*XD22))
 5              /(XK22*XD22+XC22**2)
  EPSITH      = X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)
  EPSIPH      = X1R1*(YDØT(I+5)-YPRED(I+6))+YPRED(I+7)*(X1*SAVY(3)+
 1              X2*SAVY(6))
  YDØT(I+1)   = R1*(CS1RØ*(YANTH-YPRED(I+1))-XN*X1RØ*(YPRED(I)+
 1              YAMPT*(SN*X1RØ+X1R1))+YPRED(I+2)*X1R1)-R1*K*XFPHLD
 2              -R1*((EPSITH+EPSIPH)*(X1*XFPHL1+X2*XFPHL2)-YPRED(I+7)*
 3              (X1*XFZEL1+X2*XFZEL2))
  YDØT(I+2)   = R1*(-YPRED(I+2)*CS1RØ-YANTH*SN1RØ-YPRED(I+1)*X1R1
 1              +XNSQ*YAMTH*X1RØSQ-2.0*XN*YAMPT*CS*X1RØSQ)+R1*K*
 2              (XN*XMPHLD*X1RØ-XFZELD)-R1*((EPSITH+EPSIPH)*(X1*
 3              XFZEL1+X2*XFZEL2)+YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2))
 4              -R1*X1RØ*XN*(YANPT*(X1*SAVY(3)+X2*SAVY(6))-YAØPH*
 5              (X1*SAVY(1)+X2*SAVY(4)))
  YDØT(I+3)   = R1*(YAMTH*CS1RØ-YPRED(I+3)*CS1RØ-2.0*XN*YAMPT*X1RØ+
 1              YAJPH+K*XMTHLD)
  YDØT(I+6)   = R1*(YPRED(I+7)-YPRED(I+5)*X1R1)
  YDØT(I+7)   = R1*(XK22*(YPRED(I+3)+K*XMTPH)-XC22*(YPRED(I+1)+K*
 1              XNTPH)+X1RØ
 1*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)*(XK12*XC22-XK22*XC15)
 2-(X1RØSQ*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+X1RØ*YPRED(I+7)*CS)*
 3(XC15*XC22+XK22*XD12))/(XC22**2+XK22*XD22)
  GØ TØ 9005
C EQUATIØNS FØR CØNE
 7342 YANTH       = (YPRED(I+1)+K*XNTPH)*(XC15*XC22+XD22*XK12)/(XK22*XD22+
 1 XC22**2)-K*XNTTH+(XK12*XC22-XK22*XC15)*(YPRED(I+3)+K*XMTPH)/
 2 (XC22*XC22+XK22*XD22)+(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)
 3 *SN)/(S*CS)*(XK11+(XC15*(XC15*XK22-2.0*XK12*XC22)-XK12*XK12*
 4 XD22)/(XK22*XD22+XC22*XC22))+((XN*YPRED(I+4)*SN-XNSQ*
 5 YPRED(I+6))/(S*S*CSSQ)+YPRED(I+7)/S)*(-XC11+(XC15*XC15*XC22+
 6 XC15*(XK12*XD22+XK22*XD12)-XK12*XD12*XC22)/(XK22*XD22+XC22*XC22))
  YAMTH       = (YPRED(I+3)+K*XMTPH)*(XC15*XC22+XK22*XD12)/(XK22*XD22+
 1 XC22**2)+(YPRED(I+1)+K*XNTPH)*(XD22*XC15-XD12*XC22)/(XD22*XK22+
 2 XC22**2)-K*XMTTH+(1.0/(S*S*CSSQ)*(-XNSQ*YPRED(I+6)+XN*YPRED(I+4)*
 3 SN)+YPRED(I+7)/S)*(XD11-(XD12*XD12*XK22+XC15*(2.0*XC22*XD12-XC15*
 4 XD22))/(XC22*XC22+XK22*XD22))+1.0/(S*CS)*(XN*YPRED(I+4)+
 5 YPRED(I+5)*CS-
 5 YPRED(I+6)*SN)*(XC11+(XD12*XC22*XK12-XC15*(XC15*XC22+XD12*XK22+
 6 XD22*XK12))/(XC22*XC22+XK22*XD22))
  YAØPH       = XN*YPRED(I+6)*X1CS/S-YPRED(I+4)*TAN/S
  YAMPT =((XC16*TAN/S-XK33-(TAN/S)*(XD33*TAN/S-XC16))**(-1))*((XK33*
 1        XD33-XC16**2)*(1.0/(S*CS))*(-2.0*XN*YPRED(I+7)-YPRED(I+4)*
```

```
     2        SN/S+XN*YPRED(I+5)*TAN/S+2.0*XN*YPRED(I+6)/S)+YAØPH*SN*
     3        (X1*SAVY(3)+X2*SAVY(6))+YPRED(I)*(XD33*TAN/S-XC16))
      YAJPH      = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
     1             -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT      = YPRED(I)+YAMPT*TAN/S
      YDØT(I+4)  = YPRED(I+4)/S+YAØPH*(X1*SAVY(3)+X2*SAVY(6))+XN*
     1             YPRED(I+5)/(S*CS)+(1.0/(XK33-XC16**2/
     1              XD33))*(YPRED(I)+YAMPT*(TAN/S-XC16/XD33))
      YDØT(I)   =-2.0*YPRED(I)/S+XN*YANTH*X1CS/S-XN*YAMTH*SN*X1CS**2/S**2
     1             +YAMPT*TAN/S**2-K*(XFTHLD+XMPHLD*TAN/S)-(YDØT(I+4)*
     2             (X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+X2*XFZEL2))-
     3             TAN/S*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*(X1*SAVY(3)
     4             +X2*SAVY(6)))
      YDØT(I+5)  = -YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))+(XD22*(YPRED(I+1)
     1             +K*XNTPH)+XC22*(YPRED(I+3)+K*XMTPH)-(XK12*
     1            XD22+XC15*XC22)*(1.0/(S*CS)*(XN*YPRED(I+4)+YPRED(I+5)*
     2            CS-YPRED(I+6)*SN))-(XC22*XD12-XC15*XD22)*((-XNSQ*
     3            YPRED(I+6)+XN*YPRED(I+4)*SN)/(S*S*CSSQ)+YPRED(I+7)/S))
     4            /(XK22*XD22+XC22*XC22)
      EPSITH     = (1.0/(S*CS))*(XN*YPRED(I+4)+CS*YPRED(I+5)-SN*
     1             YPRED(I+6))
      EPSIPH     = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I+1)= -YPRED(I+1)/S+YANTH/S-XN*YPRED(I)/(S*CS)-XN*YAMPT*SN/
     1             (S**2*CS**2)-K*XFPHLD-(EPSITH+EPSIPH)*(X1*XFPHL1+X2*
     2             XFPHL2)+YPRED(I+7)*(X1*XFZEL1+X2*XFZEL2)
      YDØT(I+2)  = -YPRED(I+2)/S-YANTH*TAN/S+XNSQ*YAMTH/(S**2*CS**2)
     1             -2.0*XN*YAMPT/(S**2*CS)+K*(XN*XMPHLD*X1CS/S-XFZELD)
     2             -(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-YPRED(I+7)*
     3             (X1*XFPHL1+X2*XFPHL2)-X1CS/S*XN*(YANPT*(X1*SAVY(3)+
     4             X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))
      YDØT(I+3)= YAMTH/S-YPRED(I+3)/S-2.0*XN*YAMPT/(S*CS)+YAJPH+XMTHLD
     1             *K
      YDØT(I+6)=YPRED(I+7)
      YDØT(I+7)  = (XK22*(YPRED(I+3)+K*XMTPH)-XC22*(YPRED(I+1)+K*XNTPH)+
     1            (XK12*XC22-XK22*XC15)*(1.0/(S*CS)*(XN*YPRED(I+4)+
     2            YPRED(I+5)*CS-YPRED(I+6)*SN))-(XC15*XC22+XK22*XD12)*
     3            ((-XNSQ*YPRED(I+6)+XN*YPRED(I+4)*SN)/(S*S*CSSQ)+
     4            YPRED(I+7)/S))/(XK22*XD22+XC22*XC22)
      GØ TØ 9005
C     EQUATIØNS FØR CYLINDER
 7343 YANTH      = (YPRED(I+1)+K*XNTPH)*(XC15*XC22+XD22*XK12)/(XK22*XD22+
     1 XC22**2)-K*XNTTH+(XK12*XC22-XK22*XC15)*(YPRED(I+3)+K*XMTPH)/
     2 (XC22*XC22+XK22*XD22)+X1RØ*(XN*YPRED(I+4)-
     3 YPRED(I+6))*(XK11+(XC15*(XC15*XK22-2.0*XK12*XC22)-XK12*XK12*
     4 XD22)/(XK22*XD22+XC22*XC22))+(X1RØSQ*(XN*YPRED(I+4)-XNSQ
     5 *YPRED(I+6)))*(-XC11+(XC15*XC15*XC22+
     6 XC15*(XK12*XD22+XK22*XD12)-XK12*XD12*XC22)/(XK22*XD22+XC22*XC22))
      YAMTH      = (YPRED(I+3)+K*XMTPH)*(XC15*XC22+XK22*XD12)/(XK22*XD22+
     1 XC22**2)+(YPRED(I+1)+K*XNTPH)*(XD22*XC15-XD12*XC22)/(XD22*XK22+
     2 XC22**2)-K*XMTTH+X1RØSQ*(XN*YPRED(I+4)-XNSQ*YPRED(I+6))
     3 *(XD11-(XD12*XD12*XK22+XC15*(2.0*XC22*XD12-XC15*
     4 XD22))/(XC22*XC22+XK22*XD22))+X1RØ*(XN*YPRED(I+4)-
     5 YPRED(I+6))*(XC11+(XD12*XC22*XK12-XC15*(XC15*XC22+XD12*XK22+
     6 XD22*XK12))/(XC22*XC22+XK22*XD22))
      YAØPH      = X1RØ*(XN*YPRED(I+6)-YPRED(I+4))
      YAMPT=(1/(XC16*X1RØ-XK33-X1RØ*(XD33*X1RØ-XC16)))*((XK33*XD33-XC16
     1        **2)*X1RØ*(-2.0*XN*YPRED(I+7)+XN*X1RØ*YPRED(I+5))+YAØPH*
     2        (X1*SAVY(3)+X2*SAVY(6))+YPRED(I)*(XD33*X1RØ-XC16))
      YAJPH      = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
     1             -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT      = YPRED(I)+YAMPT*X1RØ
```

```
      YDØT(I+4) = (YAØPH*(X1*SAVY(3)+X2*SAVY(6))+XN*YPRED(I+5)/RØ)+
     1             (1.0/(XK33-XC16**2/XD33))*(YPRED(I)+
     1           YAMPT*(X1RØ-XC16/XD33))
      YDØT(I)   = XN*YANTH*X1RØ-XN*YAMTH*X1RØSQ-K*(XFTHLD+XMPHLD*X1RØ)
     1             -(YDØT(I+4)*(X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+
     2             X2*XFZEL2))-X1RØ*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*
     3             (X1*SAVY(3)+X2*SAVY(6)))
      YDØT(I+5) = -YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))+(XD22*(YPRED(I+1)
     1             +K*XNTPH)+XC22*(YPRED(I+3)+K*XMTPH)-X1RØ*
     1(XN*YPRED(I+4)-YPRED(I+6))*(XK12*XD22+XC15*XC22)-X1RØSQ*(XN*YPRED
     2(I+4)-XNSQ*YPRED(I+6))*(XC22*XD12-XC15*XD22))/(XK22*XD22+XC22**2)
      EPSITH    = X1RØ*(XN*YPRED(I+4)-YPRED(I+6))
      EPSIPH    = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I+1) = -XN*X1RØ*YPRED(I)-XN*YAMPT*X1RØSQ-K*XFPHLD-(EPSITH+
     1             EPSIPH)*(X1*XFPHL1+X2*XFPHL2)+YPRED(I+7)*(X1*XFZEL1+
     2             X2*XFZEL2)
      YDØT(I+2) = -YANTH*X1RØ+XNSQ*YAMTH*X1RØSQ+K*(XN*XMPHLD*X1RØ-
     1             XFZELD)-(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-
     2             YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2)-X1RØ*XN*(YANPT*
     3             (X1*SAVY(3)+X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))
      YDØT(I+3) = -2.0*XN*YAMPT*X1RØ+YAJPH+K*XMTHLD
      YDØT(I+6)=YPRED(I+7)
      YDØT(I+7) = (XK22*(YPRED(I+3)+K*XMTPH)-XC22*(YPRED(I+1)+K*XNTPH)
     1             +X1RØ*
     1(XN*YPRED(I+4)-YPRED(I+6))*(XK12*XC22-XK22*XC15)-X1RØSQ*(XN*YPRED
     2(I+4)-XNSQ*YPRED(I+6))*(XC15*XC22+XK22*XD12))/(XC22**2+XK22*XD22)
 9005 CØNTINUE
      RETURN
       END
```

SUBROUTINE SEGMAT

The results of the subroutine link, RIEMAN, are passed through the label common area, LYCORR, to this subroutine. SEGMAT places the elements of the YCORR array into several double-subscripted arrays, forms some coordinate transformation arrays, and calls subroutine SREVN2 for double precision matrix inversion.

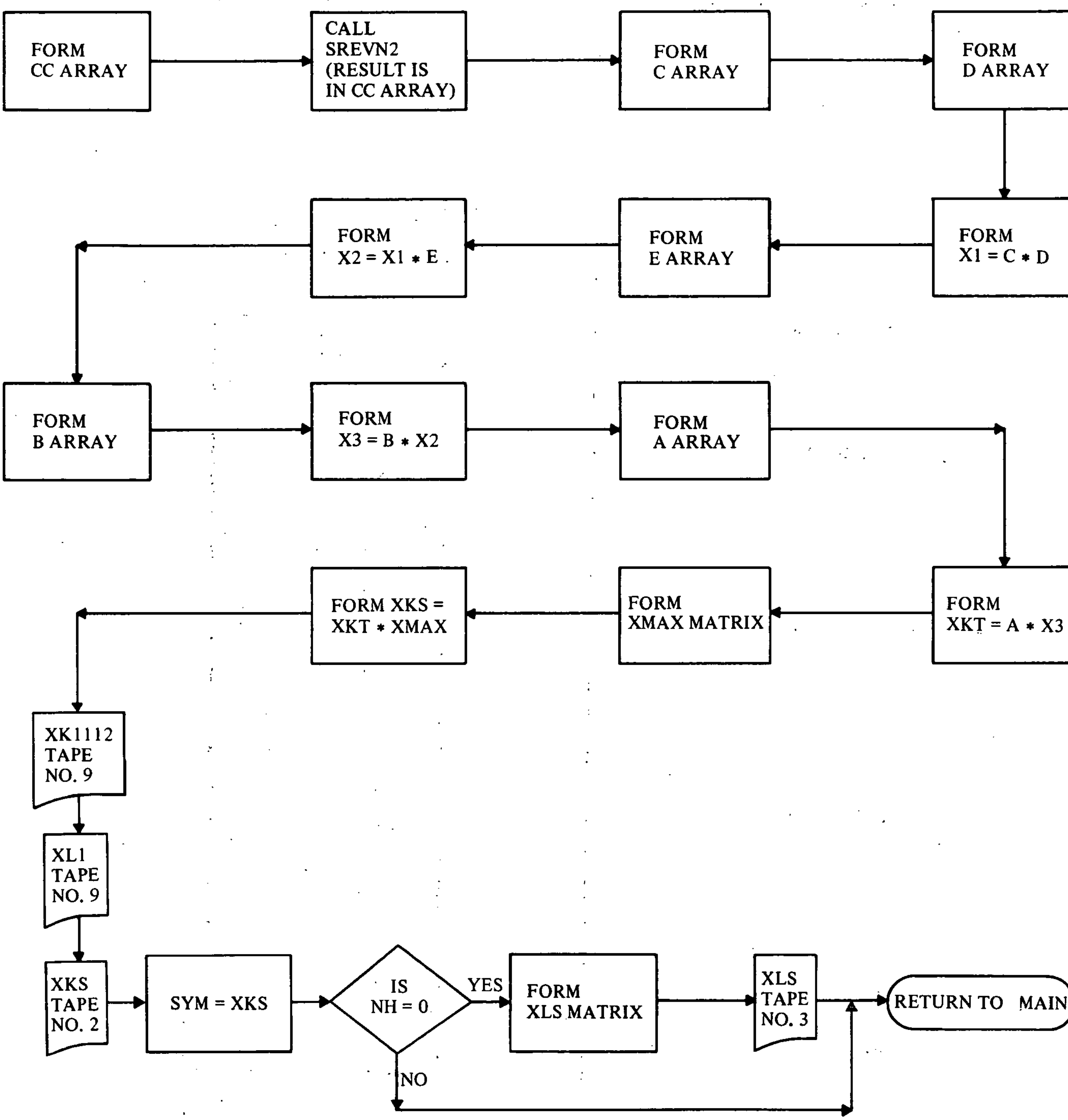
As a result of appropriate matrix operations this subroutine produces a segment stiffness matrix, the XKS array, and a segment load matrix, the XLS array, for each segment. In passes other than the first pass, first cycle, the XLS array is not calculated. SEGMAT also orients each segment into the global coordinate system of the structure as a result of the matrix operations.

Subroutine SREVN2

SREVN2 is a subroutine called by SEGMAT to invert a real, double-precision, in-core matrix utilizing Gauss-Jordan elimination with partial pivoting.

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1)
SNI	si
SNJ	sj
CSI	ci
CSJ	cj
A MATRIX	$\left[\begin{array}{c\|c} IFT & 0 \\ \hline 0 & JFT \end{array}\right]$
B MATRIX	$\left[\begin{array}{c\|c\|c} 0 & I_4 & 0 \\ \hline X_1 & X_2 & X_3 \end{array}\right]$
C MATRIX	$\left[\begin{array}{c\|c\|c} I_4 & 0 & 0 \\ \hline 0 & Y_2^{-1} & 0 \\ \hline 0 & 0 & I_p \end{array}\right]$
D MATRIX	$\left[\begin{array}{c\|c\|c} I_4 & 0 & 0 \\ \hline -Y_1 & JDT^T & -Y_3 \\ \hline 0 & 0 & I_p \end{array}\right]$
E MATRIX	$\left[\begin{array}{c\|c\|c} IDT^T & 0 & 0 \\ \hline 0 & I_4 & 0 \\ \hline 0 & 0 & I_p \end{array}\right]$
XKT MATRIX	$\left[\begin{array}{c\|c} k & \ell \end{array}\right]$
XMAX MATRIX	$\left[\begin{array}{c\|c} 2\pi r_0(i) \ddots & \\ \hline & 2\pi r_0(j) \ddots \end{array}\right]$
XKS MATRIX	${}_s[\hat{k}]^{(n)}$
XLS MATRIX	${}_s[\hat{\ell}]^{(n)}$

SEGMAT


FORM CC ARRAY
CALL SREVN2 (RESULT IS IN CC ARRAY)
FORM C ARRAY
FORM D ARRAY
FORM X1 = C * D
FORM E ARRAY
FORM X2 = X1 * E
FORM B ARRAY
FORM X3 = B * X2
FORM A ARRAY
FORM XKT = A * X3
FORM XMAX MATRIX
FORM XKS = XKT * XMAX
XK1112 TAPE NO. 9
XL1 TAPE NO. 9
XKS TAPE NO. 2
SYM = XKS
IS NH = 0
YES
NO
FORM XLS MATRIX
XLS TAPE NO. 3
RETURN TO MAIN

```
C ..... RØUTINE **D7        ** ABACUS UPDATED 07/07/72 .....                700000
      SUBRØUTINE SEGMAT                                                     700010
      INTEGER SAVJTC,SAVSTP,Q,THICK
      INTEGER XN1,XN                                                        700030
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK,YCØRR,A1
      DØUBLE PRECISIØN C,CC,D,E,B,A,X1,X2,X3,XKT,XMAX,XKS
      DØUBLE PRECISIØN RI,RJ,CSI,CSJ,SNI,SNJ,X2PIRI,X2PIRJ
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)             700050
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)                                700060
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(2),NH               700070
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)      700080
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB     700090
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE     700100
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS                700110
      CØMMØN /LYCØRR/ YCØRR(80)                                             700120
      DIMENSIØN C(18,18),CC(4,4),D(18,18),E(18,18),B(8,18),A(8,8)           700130
      DIMENSIØN X1(18,18),X2(18,18),X3(8,18),XKT(8,18),XMAX(8,18)           700140
      DIMENSIØN XKS(8,18),XLS(8,2),SYM(8,18)                                700150
      DIMENSIØN  DEAD(4)                                                    700160
      DIMENSIØN LABEL(16)                                                   700170
      DIMENSIØN      N1(2)    ,N2(2)    ,N3(2)    ,N4(2)                    700180
      DIMENSIØN      N5(2)    ,N6(2)    ,N7(2)    ,N8(2)                    700190
      EQUIVALENCE (LABEL( 1),N1(1))   , (LABEL( 3),N2(1))                   700200
      EQUIVALENCE (LABEL( 5),N3(1))   , (LABEL( 7),N4(1))                   700210
      EQUIVALENCE (LABEL( 9),N5(1))   , (LABEL(11),N6(1))                   700220
      EQUIVALENCE (LABEL(13),N7(1))   , (LABEL(15),N8(1))                   700230
      EQUIVALENCE (C(1),E(1),X3(1),XMAX(1),XLS(1))                          700240
      EQUIVALENCE (X2(1),D(1),A(1),XKS(1)),(X1(1),B(1),XKT(1),SYM(1))       700250
      SIN(X) = DSIN(X)                                                      700300
      CØS(X) = DCØS(X)                                                      700310
      DATA N1                 /8HFØRCE T1/                                  700320
      DATA N2                 /8HFØRCE Z1/                                  700330
      DATA N3                 /8HFØRCE R1/                                  700340
      DATA N4                 /8HMØMENT 1/                                  700350
      DATA N5                 /8HFØRCE T2/                                  700360
      DATA N6                 /8HFØRCE Z2/                                  700370
      DATA N7                 /8HFØRCE R2/                                  700380
      DATA N8                 /8HMØMENT 2/                                  700390
      IF (NH.EQ.0) WRITE(6,1726)                                            700410
 1726 FØRMAT(1H1)                                                           700420
      A1=G1                                                                 700430
      GØTØ (601,602,603),IGEØM                                              700440
  601 SNI = SIN(TIC)                                                        700450
      SNJ = SIN(STØP)                                                       700460
      CSI = CØS(TIC)                                                        700470
      CSJ = CØS(STØP)                                                       700480
      GØTØ 1                                                                700490
  602 SNI = CØS(1.570796-A1)                                                700500
      SNJ = SNI                                                             700510
      CSI = SIN(1.570796-A1)                                                700520
      CSJ = CSI                                                             700530
      GØTØ 1                                                                700540
  603 SNI = 1.0                                                             700550
      SNJ = 1.0                                                             700560
      CSI = 0.0                                                             700570
      CSJ = 0.0                                                             700580
    1 JJ = 8+NPRØB                                                          700590
      DØ 111 J=1,18                                                         700600
      DØ 111 I=1,18                                                         700610
  111 C(I,J)=0.0                                                            700620
```

```
      K=28
      DØ 112 J=1,4
      K=K+8
      L=K
      DØ 112 I=1,4
      L=L+1
  112 CC(I,J)=YCØRR(L)
      CALL SREVN2 (CC,4,DEAD,4,NIX)
      IF (NIX.NE.0) GØTØ 8120
      J1=0
      DØ 113 J=5,8
      J1=J1+1
      II=0
      DØ 113 I=5,8
      II=II+1
  113 C(I,J)=CC(II,J1)
      DØ 114 IJ=1,4
  114 C(IJ,IJ)=1.0
      DØ 115 IJ=9,JJ
  115 C(IJ,IJ)=1.0
      DØ 116 J=1,18
      DØ 116 I=1,18
  116 D(I,J)=0.0
      DØ 117 IJ=1,4
  117 D(IJ,IJ)=1.0
      I=5
      D(I,I)=1.0
      D(I+1,I+1)=-SNJ
      D(I+2,I+2)=-SNJ
      D(I+3,I+3)=1.0
      D(I+1,I+2)= CSJ
      D(I+2,I+1)=-CSJ
      DØ 218 IJ=9,JJ
  218 D(IJ,IJ)=1.0
      K=-4
      DØ 118 J=1,4
      K=K+8
      L=K
      DØ 118 I=5,8
      L=L+1
  118 D(I,J)= -YCØRR(L)
      K=60
      DØ 119 J=9,JJ
      K=K+8
      L=K
      DØ 119 I=5,8
      L=L+1
  119 D(I,J)=-YCØRR(L)
      DØ 120 J=1,JJ
      DØ 120 I=1,JJ
      X1(I,J)=0.0
      DØ 120 M=1,JJ
  120 X1(I,J)=X1(I,J)+C(I,M)*D(M,J)
      DØ 121 J=1,18
      DØ 121 I=1,18
  121 E(I,J)=0.0
      I=1
      E(I,I)=1.0
      E(I+1,I+1)=-SNI
      E(I+2,I+2)=-SNI
      E(I+3,I+3)=1.0
```

```
      E(I+1,I+2)=CSI                                                    701240
      E(I+2,I+1)=-CSI                                                   701250
      DØ 122 J=5,JJ                                                     701260
  122 F(J,J)=1.0                                                        701270
      DØ 123 J=1,JJ                                                     701280
      DØ 123 I=1,JJ                                                     701290
      X2(I,J)=0.0                                                       701300
      DØ 123 M=1,JJ                                                     701310
  123 X2(I,J)=X2(I,J)+X1(I,M)*E(M,J)                                    701320
      DØ 124 J=1,JJ                                                     701330
      DØ 124 I=1,8                                                      701340
  124 B(I,J)=0.0                                                        701350
      J=4                                                               701360
      DØ 125  I=1,4                                                     701370
      J=J+1                                                             701380
  125 B(I,J)=1.0                                                        701390
      K=-8                                                              701400
      DØ 126 J=1,4                                                      701410
      K=K+8                                                             701420
      L=K                                                               701430
      DØ 126 I=5,8                                                      701440
      L=L+1                                                             701450
  126 B(I,J)=YCØRR(L)                                                   701460
      K = 24                                                            701470
      DØ 127 J=5,8                                                      701480
      K=K+8                                                             701490
      L=K                                                               701500
      DØ 127 I=5,8                                                      701510
      L=L+1                                                             701520
  127 B(I,J)=YCØRR(L)                                                   701530
      K=56                                                              701540
      DØ 128 J=9,JJ                                                     701550
      K=K+8                                                             701560
      L=K                                                               701570
      DØ 128 I=5,8                                                      701580
      L=L+1                                                             701590
  128 B(I,J)=YCØRR(L)                                                   701600
      DØ 129 J=1,JJ                                                     701610
      DØ 129 I=1,8                                                      701620
      X3(I,J)=0.0                                                       701630
      DØ 129 M=1,JJ                                                     701640
  129 X3(I,J)=X3(I,J)+B(I,M)*X2(M,J)                                    701650
      DØ 130 J=1,8                                                      701660
      DØ 130 I=1,8                                                      701670
  130 A(I,J)=0.0                                                        701680
      I=1                                                               701690
      A(I,I)=-1.0                                                       701700
      A(I+1,I+1)=SNI                                                    701710
      A(I+2,I+2)=SNI                                                    701720
      A(I+1,I+2)=CSI                                                    701730
      A(I+2,I+1)=-CSI                                                   701740
      A(I+3,I+3)=1.0                                                    701750
      I=5                                                               701760
      A(I,I)=1.0                                                        701770
      A(I+1,I+1)=-SNJ                                                   701780
      A(I+2,I+2)=-SNJ                                                   701790
      A(I+3,I+3)=-1.0                                                   701800
      A(I+1,I+2)=-CSJ                                                   701810
      A(I+2,I+1)=CSJ                                                    701820
      DØ 131 J=1,JJ                                                     701830
      DØ 131 I=1,8                                                      701840
```

```
      XKT(I,J)=0.0
      DØ 131 M=1,8
  131 XKT(I,J)=XKT(I,J)+A(I,M)*X3(M,J)
      PI=3.1415927
      RI=RTICK
      X2PIRI=2.0*PI*RI
      RJ=RESTØP
      X2PIRJ=2.0*PI*RJ
      DØ 132 J=1,8
      DØ 132 I=1,8
  132 XMAX(I,J)=0.0
      DØ 133 I=1,4
  133 XMAX(I,I)=X2PIRI
      DØ 134 J=5,8
  134 XMAX(J,J)=X2PIRJ
      DØ 135  J=1,JJ
      DØ 135 I=1,8
      XKS(I,J)=0.0
      DØ 135 M=1,8
  135 XKS(I,J)=XKS(I,J)+XMAX(I,M)*XKT(M,J)
      DØ 139 J=1,JJ
      DØ 139 I=1,4
  139 SYM(I,J) = XKT(I,J)
      WRITE(9) ((SYM(I,J),J=1,8),I=1,4),IGEØM,G1
      IF (NH.EQ.0) WRITE(9) ((SYM(I,J),J=9,JJ),I=1,4)
      IF (NH.EQ.0.ØR.IBEGIN.EQ.1) WRITE(6,781)
  781 FØRMAT(//////55X,22HSTIFFNESS CØEFFICIENTS//14X,8HDELTA T1,7X,
     1 8HDELTA Z1,7X,8HDELTA R1,7X,7HTHETA 1,8X,8HDELTA T2,7X,8HDELTA Z2
     2 ,7X,8HDELTA R2,7X,7HTHETA 2)
      III=0
      DØ 20 M=1,8
      II =III+1
      III=II+1
      IF (NH.EQ.0.ØR.IBEGIN.EQ.1) WRITE(6,23) (LABEL(I),I=II,III),
     1                              (XKS(M,J),J=1,8)
   23 FØRMAT(/1X,2A4,1X,8(E14.7,1X))
      DØ 20 J=1,8
      SYM(M,J) = XKS(M,J)
   20 CØNTINUE
 9968 FØRMAT(1H ,8(E14.7,2X)/(5X,8(E14.7,2X)))
      J1=8
      ISEG=0
      NRC1=NRC-1
      IF(NRC1.EQ.0)GØTØ 143
      DØ 244 I=1,NRC1
  244 ISEG=ISEG+NST(I)
  143 ISEG=ISEG+NSC
      SAVTIC(ISEG)=TIC
      WRITE(2) ((SYM(I,J),J=1,8),I=1,8)
      DØ 137 J=1,8
      DØ 137 I=1,8
  137 SYM(I,J)=0.0
      INDEC=0
      DØ 138 I=1,8
      DØ 138 J=1,8
      IF(J.NE.I)GØ TØ 138
      IF(XKS(I,J).GE.0.0)GØ TØ 138
      INDEC=1
  138 SYM(I,J)=XKS(I,J)
      IF(INDEC.EQ.0)GØ TØ 151
      IF (NH.NE.0) GØ TØ 151
```

```
      WRITE(6,152)
  152 FØRMAT(////- ***********************************   WARNING - NEGATI
     1VES APPEAR ØN MAIN DIAGØNAL. REVISE SIZING   ****************-//)
  151 JJ=2
      N  = 8
      J  = 1
      DØ 42  II=1,7
      M  = JJ
      DØ 43  I=M,N
      ALPH = ABS(SYM(I,J)) - ABS(SYM(J,I))
      IF(ALPH) 47,71,48
   47 IF(SYM(I,J).EQ.0.0) GØTØ 71
      SYM(I,J) = SYM(J,I) / SYM(I,J)
      GØTØ 43
   48 IF(SYM(J,I).EQ.0.0) GØTØ 71
      SYM(I,J) = SYM(I,J) / SYM(J,I)
      GØTØ 43
   71 SYM(I,J) = 1.0
   43 SYM(J,I) = 0.0
      JJ = JJ +1
      J = J+1
   42 CØNTINUE
      IF (NH.NE.0.AND.IBEGIN.NE.1) GØ TØ 145
      WRITE(6,785)
  785 FØRMAT(//55X,22HSEGMENT SYMMETRY CHECK,)
      DØ 144 I=1,8
  144 WRITE(6,9968)  (SYM(I,J),J=1,8)
  145 IF (NPRØB.EQ.0) GØ TØ 9999
      DØ 136 J=1,NPRØB
      J1=J1+1
      DØ 136 I=1,8
  136 XLS(I,J)=XKS( I,J1)
      WRITE(3)((XLS(I,J),J=1,NPRØB),I=1,8)
      WRITE (6,782)
  782 FØRMAT(//55X,22HSEGMENT LØAD MATRICES ,)
      DØ 840 I=1,8
  840 WRITE(6,9968)(XLS(I,J),J=1,NPRØB)
      GØTØ 9999
 8120 IERRØR=8120
      NERRØR=29
 8888 NIX=1
 9999 CØNTINUE
      IF (NH.EQ.0.ØR.IBEGIN.EQ.1) WRITE(6,795) RTICK,RESTØP
  795 FØRMAT(    /- RZERØ(I) =-,1PE15.6,10X,-RZERØ(J) =-,1PE15.6)
      RETURN
       END
```

```
C ..... RØUTINE **D8       ** ABACUS UPDATED 07/07/72 .....          800000
      SUBRØUTINE SREVN2(A,M,LØC,MID,NIX)                             800010
      DØUBLE PRECISIØN A(MID,1),PIVØT,TEMP1
      INTEGER LØC(1)                                                 800030
  100 N = M                                                          800040
      DØ 190  K = 1,N                                                800050
      PIVØT = 0.D0                                                   800060
      DØ 120  I = K,N                                                800070
      IF (PIVØT - DABS(A(I,K))) 110,110,120                          800080
  110 PIVØT = DABS(A(I,K))                                           800090
      L = I                                                          800100
  120 CØNTINUE                                                       800110
      IF (PIVØT) 140,130,140                                         800120
  130 NIX = -1                                                       800130
      GØ TØ 210                                                      800140
  140 LØC(K) = L                                                     800150
      DØ 150  J = 1,N                                                800160
      TEMP1 = A(K,J)                                                 800170
      A(K,J) = A(L,J)                                                800180
  150 A(L,J) = TEMP1                                                 800190
      TEMP1 = A(K,K)                                                 800200
      A(K,K) = 1.D0                                                  800210
      DØ 160  J = 1,N                                                800220
  160 A(K,J) = A(K,J)/TEMP1                                          800230
      DØ 190  I = 1,N                                                800240
      IF (I - K) 170,190,170                                         800250
  170 TEMP1 = -A(I,K)                                                800260
      A(I,K) = 0.D0                                                  800270
      DØ 180   J = 1,N                                               800280
  180 A(I,J) = A(I,J) + TEMP1*A(K,J)                                 800290
  190 CØNTINUE                                                       800300
      DØ 200  K = 1,N                                                800310
      NK = N - K                                                     800320
      L = LØC(NK+1)                                                  800330
      DØ 200  I = 1,N                                                800340
      TEMP1 = A(I,NK+1)                                              800350
      A(I,NK+1) = A(I,L)                                             800360
  200 A(I,L) = TEMP1                                                 800370
      NIX = 0                                                        800380
  210 RETURN                                                         800390
      END                                                            800400
```

SUBROUTINE REGMAT

The segment stiffness matrices, XKS, and the segment load matrices, XLS, are passed from SEGMAT to REGMAT via Tapes #2 and #3, and are placed in the XKRTOT array and the XLRTOT array, respectively. If kinematic links occur between segments in the region, the XKRTOT array and the XLRTOT array are modified to represent the situation. In the case of discrete rings the routine RINGER is called and provides the necessary matrices.

A horizontal and vertical partitioning of the XKRTOT array occurs while the XLRTOT array is subjected to a horizontal partitioning only. Appropriate matrix operations are performed upon the partitions of each array, thus reducing the size of the region stiffness and load matrices and resulting in increased program capacity. The results of these manipulations are the region stiffness matrix, XKR, and the region load matrix, XLR. In passes other than the first pass, first cycle, the load calculations are not performed.

Subroutines Called from REGMAT

Subroutine SWITCH: Is a routine used to arrange a matrix in a form convenient for use by another routine employing a positive definite method for solving linear algebraic equations.

Subroutine CHASE: Is a routine used to obtain the solution X of the linear system AX = Y, given at least one right side of Y and the positive, definite, symmetric, real coefficient matrix A.

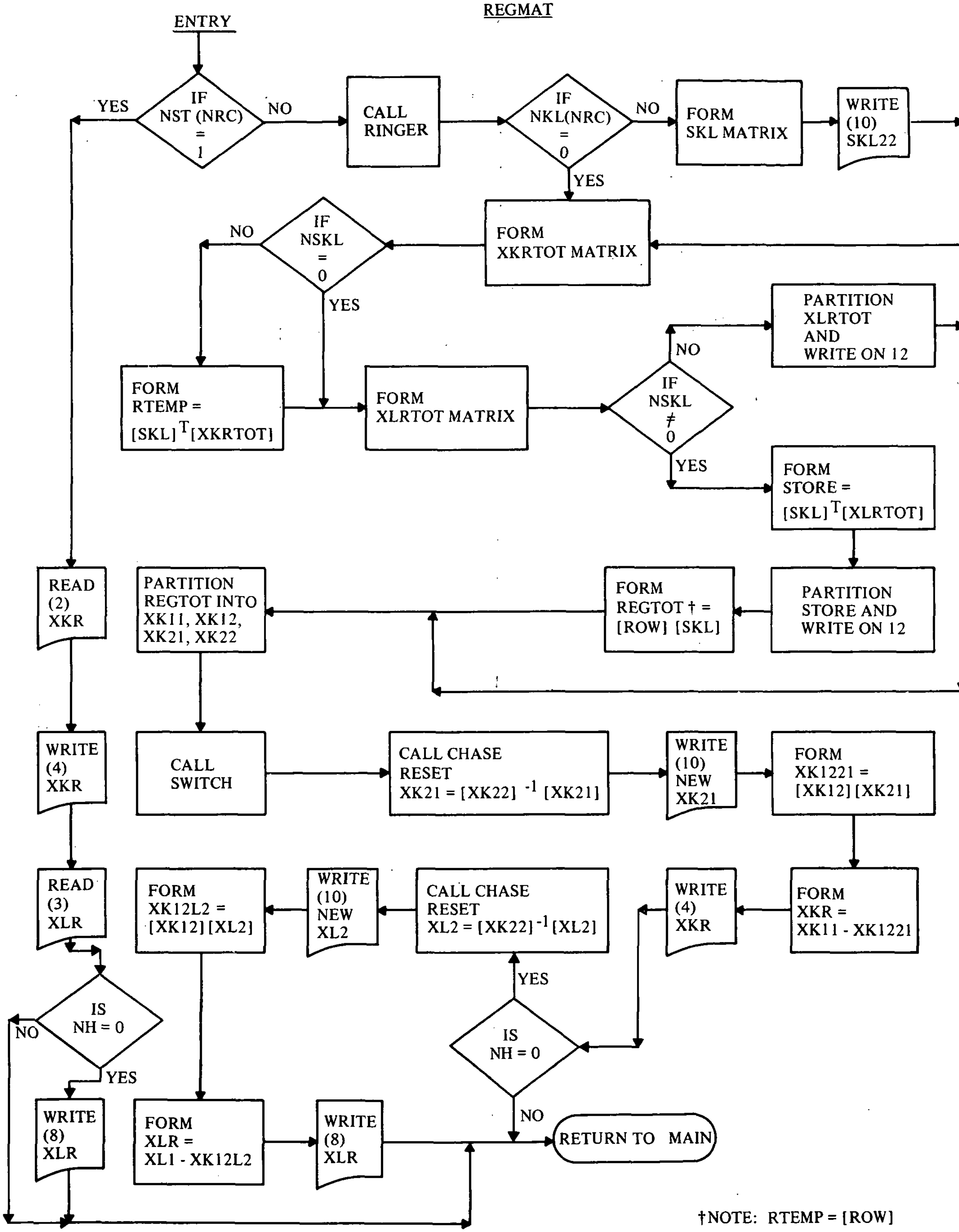
Subroutine FUTILE: Is a routine called from CHASE and used to obtain the factorization of the positive definite, real, symmetric matrix A into the product of a lower triangular matrix and its transpose by utilizing a Cholesky decomposition.

Subroutine TRIEQ: Is a routine called by CHASE or EIGVAL to solve a triangular system of algebraic equations.

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1)
SKL MATRIX	$\left[SKL \right]$
SKLTR MATRIX	$\left[SKL \right]^T$
XKRTOT MATRIX	$\widehat{\left[\begin{array}{c\|c} K'_{11} & K'_{12} \\ \hline K'_{21} & K'_{22} \end{array} \right]}$
XLRTOT MATRIX	$\widehat{\left[\begin{array}{c} L'_{iR1} \\ L'_{jR1} \\ \hline L' \end{array} \right]}$
SKL22 MATRIX	$\left[SKL_{22} \right]$
REGTOT MATRIX	$\widehat{\left[\begin{array}{c\|c} K_{11} & K_{12} \\ \hline K_{21} & K_{22} \end{array} \right]}$
STORE MATRIX	$\widehat{\left[\begin{array}{c} L_{iR1} \\ L_{jR1} \\ \hline L \end{array} \right]}$
XK11 PARTITION	$\widehat{\left[K_{11} \right]}$
XK12 PARTITION	$\widehat{\left[K_{12} \right]}$
XK22 PARTITION	$\widehat{\left[K_{22} \right]}$
XK21 PARTITION	$\widehat{\left[K_{21} \right]}$

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1)
XL1 PARTITION	$\left[\hat{L}_{R1}\right]$
XL2 PARTITION	$\left[\hat{L}\right]$
XKR MATRIX	$\left[\hat{K}_{R}\right]$
XLR MATRIX	$\left[\hat{L}_{R}\right]$

REGMAT



†NOTE: RTEMP = [ROW]

```
C ..... RØUTINE **D9       ** ABACUS UPDATED 07/24/72 .....
      SUBRØUTINE REGMAT
      INTEGER SAVJTC,SAVSTP,Q,THICK
      INTEGER XN1,XN
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(2),NH
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS
      CØMMØN /ØPT2/ PRINT
      CØMMØN /ARING/ NRING(28),AMAT(30,4),IRLC(28)
      DIMENSIØN ØPEN(4,4)
      DIMENSIØN XTEMP(8,8),SKL(120,120),SKLTR(120)
      DIMENSIØN SYM(8,8)
      DIMENSIØN XKRTØT(120,120),RTEMP(120),XLRTØT(120,2),XKEEP(8,2)
      DIMENSIØN STØRE(120,2),RØW(120),REGTØT(120),HØLD(4,120)
      DIMENSIØN XK22(112,112),XK11(8,8),XK12(8,112),XK21(112,8)
      DIMENSIØN XKIV(6328),XK1221(8,8),XKR(8,8)
      DIMENSIØN XL1(8,2),XL2(112,2),XK12L2(8,2),XLR(8,2)
      DIMENSIØN JDEP(112),JIND(15),ANGLE(15)
      DIMENSIØN RNGTØT(4,4),RNGLØD(4,28),JTNØ(28)
      DIMENSIØN LABEL(16)
      DIMENSIØN     N1(2)     ,N2(2)     ,N3(2)     ,N4(2)
      DIMENSIØN     N5(2)     ,N6(2)     ,N7(2)     ,N8(2)
      EQUIVALENCE (SYM(1),XK12L2(1),XK1221(1),HØLD(1),JDEP(1))
      EQUIVALENCE (LABEL( 1),N1(1)),(LABEL( 3),N2(1))
      EQUIVALENCE (LABEL( 5),N3(1)),(LABEL( 7),N4(1))
      EQUIVALENCE (LABEL( 9),N5(1)),(LABEL(11),N6(1))
      EQUIVALENCE (LABEL(13),N7(1)),(LABEL(15),N8(1))
      EQUIVALENCE (SKL(1),XKRTØT(1),XK22(1),XKIV(1),XLRTØT(1))
      EQUIVALENCE (XKR(1),XK11(1),XTEMP(1),XLR(1),XL1(1),XKEEP(1),
     1             RTEMP(1),RØW(1))
      EQUIVALENCE (SKLTR(1),REGTØT(1),ØPEN(1),XK12(1))
      EQUIVALENCE (STØRE(1),XL2(1),XK21(1))
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK
      DATA N1                 /8HFØRCE T1/
      DATA N2                 /8HFØRCE Z1/
      DATA N3                 /8HFØRCE R1/
      DATA N4                 /8HMØMENT 1/
      DATA N5                 /8HFØRCE T2/
      DATA N6                 /8HFØRCE Z2/
      DATA N7                 /8HFØRCE R2/
      DATA N8                 /8HMØMENT 2/
      REWIND  2
      REWIND 3
      REWIND 12
      D = 0.0
      PRINT = 0.0
      NØJ = NST(NRC) + NKL(NRC) +1
      NØJ4 = NØJ*4
      NSKL = NKL(NRC)
      NH4=4
      NJTNH4=NH4*NØJ
      NJINK4 = (NØJ-NSKL)*4
      M8=NJINK4-8
      NKIV = NJINK4 - 8
      IF (NST(NRC).EQ.1) GØTØ 1
      IF (NH.NE.O.AND.IBEGIN.NE.1) GØ TØ 690
```

```
      WRITE(6,1726)                                                    900600
 1726 FØRMAT(1H1)                                                      900610
      WRITE(6,681) NRC,NØJ,NSKL                                        900620
  681 FØRMAT(////51X31HINPUT DATA FØR SEGMENT CØUPLING///25X14HREGIØN NU 900630
     1MBER ,I2,5X25HNUMBER ØF SEGMENT JØINTS ,I3,5X,26HNUMBER ØF KINEMAT 900640
     2IC LINKS ,I3//)                                                  900650
      WRITE(6,682)                                                     900660
  682 FØRMAT(41X,7HSEGMENT,11X,8HJØINT(I),11X,8HJØINT(J)//)            900670
      DØ 683 I=1,NSEG                                                  900690
      KTIC = SAVJTC(I)                                                 900700
      KSTØP= SAVSTP(I)                                                 900710
      WRITE(6,684) I,KTIC,KSTØP                                        900720
  684 FØRMAT(43X,2(I3,16X),I3)                                         900730
  683 CØNTINUE                                                         900740
  690 CØNTINUE                                                         900750
      NNT = NST(NRC)                                                   900760
      DØ 350 I=1,NØJ4                                                  900770
      DØ 350 J=1,NØJ4                                                  900780
  350 XKRTØT(I,J)=0.0                                                  900790
  591 FØRMAT (3I5,16A4)                                                900800
      DØ 701 NS=1,NNT                                                  900810
      READ(2) ((XTEMP(I,J),J=1,8),I=1,8)                               900820
      J1 = SAVJTC(NS)                                                  900830
      J2 = SAVSTP(NS)                                                  900840
      II = 4*(J1-1)                                                    900850
       L = II                                                          900860
      IF (J1.GT.J2) GØTØ 950                                           900870
      DØ 910  I = 1,8                                                  900880
       JJ = L                                                          900890
      II = II + 1                                                      900900
      DØ 910  J = 1,8                                                  900910
      JJ = JJ + 1                                                      900920
  910 XKRTØT(II,JJ)=XKRTØT(II,JJ)+XTEMP(I,J)                           900930
      GØTØ 701                                                         900940
  950 JJ = 4*(J2-1)+1                                                  900950
      II = II + 1                                                      900960
      DØ 960  JK = 1,4                                                 900970
      GØTØ (951,952,953,954) , JK                                      900980
  951 IX = II                                                          900990
      IND = II                                                         901000
      DØ 961 I=1,4                                                     901010
      DØ 961 J=1,4                                                     901020
  961 ØPEN(I,J) = XTEMP(I,J)                                           901030
      GØTØ 955                                                         901040
  952 IX = II                                                          901050
      IND = JJ                                                         901060
      DØ 962 I=1,4                                                     901070
      DØ 962 J=1,4                                                     901080
  962 ØPEN(I,J) = XTEMP(I,J+4)                                         901090
      GØTØ 955                                                         901100
  953 IX = JJ                                                          901110
      IND = II                                                         901120
      DØ 963 I=1,4                                                     901130
      DØ 963 J=1,4                                                     901140
  963 ØPEN(I,J) = XTEMP(I+4,J)                                         901150
      GØTØ 955                                                         901160
  954 IX = JJ                                                          901170
      IND = JJ                                                         901180
      DØ 964 I=1,4                                                     901190
      DØ 964 J=1,4                                                     901200
  964 ØPEN(I,J) = XTEMP(I+4,J+4)                                       901210
```

```
  955 DØ 956 I=1,4
      JX = IND
      DØ 957 J=1,4
      XKRTØT(IX,JX) = XKRTØT(IX,JX) + ØPEN(I,J)
  957 JX = JX + 1
  956 IX = IX + 1
  960 CØNTINUE
  701 CØNTINUE
      NRNG = NRING(NRC)
      IF (NRING(NRC).EQ.0) GØ TØ 210
      IF (Q.EQ.5) WRITE(6,300)
  300 FØRMAT(///)
      MFLG = 1
      DØ 211 J=1,NRNG
      CALL RINGER (Q,XN,RNGTØT,RNGLØD,J,RADUS,TADUS,SAVJTC,SAVSTP,JTNØ,
     1             KBC,XNL,MFLG,NSEG)
      JT = 4*(JTNØ(J)-1)
      DØ 220 I=1,4
      DØ 220 IK=1,4
  220 XKRTØT(JT+I,JT+IK) = XKRTØT(JT+I,JT+IK)+RNGTØT(I,IK)
  211 CØNTINUE
      IF (Q.NE.5) GØ TØ 210
      WRITE(6,300)
      READ(5,2000)
  210 CØNTINUE
      REWIND   2
      IF(NSKL.NE.0) GØ TØ 931
      DØ 5504 I=1,NØJ4
      WRITE(2) (XKRTØT(I,J),J=1,NØJ4)
 5504 CØNTINUE
      GØ TØ 101
  931 CØNTINUE
      WRITE(12) ((XKRTØT(I,J),J=1,NØJ4),I=1,NØJ4)
      REWIND 12
      DØ 501 J=1,NJTNH4
      DØ 501 I=1,NJTNH4
  501 SKL(I,J)=0.0
      IF (NH.EQ.0) WRITE(6,685)
  685 FØRMAT(//60X13HSEGMENT LINKS//43X8HJØINT(J)5X8HJØINT(I)5X20HANGLE
     1ØF ØRIENTATIØN//)
      DØ 103  NRIG = 1,NSKL
      IF (Q.EQ.1) GØ TØ 566
      READ(5,503) JDEP(NRIG),JIND(NRIG),ANGLE(NRIG)
  503 FØRMAT (2I2,E14.7,15A4)
      WRITE(1) JDEP(NRIG),JIND(NRIG),ANGLE(NRIG)
      WRITE(6,686) JDEP(NRIG),JIND(NRIG),ANGLE(NRIG)
  686 FØRMAT(45X,I3,10X,I3,11X,E14.7)
      IF(JIND(NRIG).GE.JDEP(NRIG)) GØ TØ 8797
      GØ TØ 103
  566 READ(1) JDEP(NRIG),JIND(NRIG),ANGLE(NRIG)
  103 CØNTINUE
      IF (Q.EQ.5) READ(5,2000)
 2000 FØRMAT(1X)
      J = -3
      N = 1
      DØ 100  IJ = 1,NØJ
      I = 4*IJ-3
      IF(IJ.EQ.JDEP(N)) GØTØ 11
      J = J + 4
      GØTØ 12
   11 JD = JDEP(N)
```

```
      JI = JIND(N)
      CØTAN = CØS(ANGLE(N))/SIN(ANGLE(N))
      IF(N.LT.NRIG) N=N+1
      SKL(  I,   J) = RADUS(JD)/RADUS(JI)
      SKL(I+1,J+3) =-(RADUS(JD)-RADUS(JI))
      SKL(I+2,J+3) =-SKL(I+1,J+3)*CØTAN
      GØTØ 13
   12 SKL(  I,   J) = 1.0
   13 SKL(I+1,J+1) = 1.0
      SKL(I+2,J+2) = 1.0
      SKL(I+3,J+3) = 1.0
  100 CØNTINUE
 5000 FØRMAT(1H ,8(E14.7,2X)/(5X,8(E14.7,2X)))
      II = NØJ4 - 4
      JJ = NJINK4 - 4
      DØ 768 I=5,II
  768 WRITE(10) (SKL(I,J),J=5,JJ)
      DØ 702 J=1,NJINK4
  702 WRITE(2)  (SKL(I,J),I=1,NØJ4)
      WRITE(2) ((SKL(I,J),J=1,NJINK4),I=1,NØJ4)
      REWIND 2
      READ(12) ((XKRTØT(I,J),J=1,NØJ4),I=1,NØJ4)
      REWIND 12
 1000 CØNTINUE
      DØ 740 I=1,NJINK4
      READ(2) (SKLTR(J),J=1,NØJ4)
      DØ 741 J=1,NØJ4
      RTEMP  (J)=0.0
      DØ 741 K=1,NØJ4
  741 RTEMP  (J)=RTEMP  (J)+SKLTR(K)*XKRTØT(K,J)
      WRITE(12) (RTEMP  (J),J=1,NØJ4)
  740 CØNTINUE
      REWIND 12
  101 IF (NPRØB.EQ.0) GØ TØ 1001
      REWIND 2
      DØ 436 I=1,NØJ4
      DØ 436 J=1,NPRØB
  436 XLRTØT(I,J)=0.0
      DØ  971 NS = 1,NNT
      JTIC = SAVJTC(NS)
      JSTØP= SAVSTP(NS)
      READ (3) ((XKEEP(I,J),J=1,NPRØB),I=1,8)
      DØ  971 N =1,2
      GØTØ (981,982),N
  981 II = (JTIC-1)*4 + 1
      III= II + 3
      GØTØ 983
  982 II = (JSTØP-1)*4 +1
      III= II + 3
  983 DØ  971 J=1,NPRØB
      I =0
      IF (N.EQ.2) I=4
      DØ  971 IL = II,III
      I = I + 1
  971 XLRTØT(IL,J)= XLRTØT(IL,J)+ XKEEP(I,J)
      IF (NRNG.EQ.0) GØ TØ 230
      DØ 225 J=1,NRNG
      JT = 4*(JTNØ(J)-1)
      DØ 226 I=1,4
      DØ 226 IK=1,NPRØB
      IF (IK.EQ.1.AND.IRLC(J).EQ.2) GØ TØ 226
```

```
      XLRTØT(JT+I,IK) = XLRTØT(JT+I,IK)+RNGLØD(I,J)                    902430
  226 CØNTINUE                                                          902431
  225 CØNTINUE                                                          902470
  230 CØNTINUE                                                          902480
      REWIND 3                                                          902490
      IF (NSKL.NE.0) GØTØ 147                                           902500
      DØ 119 I=1,4                                                      902510
  119 WRITE(3) (XLRTØT(I,J),J=1,NPRØB)                                  902520
      M3=NJINK4-3                                                       902530
      DØ 118 I=M3,NJINK4                                                902540
  118 WRITE(3) (XLRTØT(I,J),J=1,NPRØB)                                  902550
      M4=NJINK4-4                                                       902560
      DØ 117 I=5,M4                                                     902570
  117 WRITE(3) (XLRTØT(I,J),J=1,NPRØB)                                  902580
      REWIND 3                                                          902590
      GØTØ 102                                                          902600
  147 DØ 747  I=1,NJINK4                                                902610
      READ(2) (SKLTR(J),J=1,NØJ4)                                       902620
      DØ 748  J=1,NPRØB                                                 902630
      STØRE(I,J)=0.0                                                    902640
      DØ 748   K=1,NØJ4                                                 902650
  748 STØRE(I,J)=STØRE(I,J)+SKLTR(K)*XLRTØT(K,J)                        902660
  747 CØNTINUE                                                          902670
      DØ 919 I=1,4                                                      902680
  919 WRITE(3) (STØRE(I,J),J=1,NPRØB)                                   902690
      M3=NJINK4-3                                                       902700
      DØ 918 I=M3,NJINK4                                                902710
  918 WRITE(3) (STØRE(I,J),J=1,NPRØB)                                   902720
      M4=NJINK4-4                                                       902730
      DØ 917 I=5,M4                                                     902740
  917 WRITE(3) (STØRE(I,J),J=1,NPRØB)                                   902750
      REWIND 3                                                          902760
 1001 CØNTINUE                                                          902770
      IF (NSKL.EQ.0) GØ TØ 102                                          902780
      READ(2) ((SKL(I,J),J=1,NJINK4),I=1,NØJ4)
      REWIND 2                                                          902800
      DØ 750 I=1,NJINK4                                                 902820
      READ(12) (RØW(J),J=1,NØJ4)                                        902830
      DØ 751 J=1,NJINK4                                                 902840
      REGTØT  (J)=0.0                                                   902850
      DØ 751 K=1,NØJ4                                                   902860
  751 REGTØT  (J)=REGTØT  (J)  +  RØW(K)*SKL(K,J)                       902870
  750 WRITE(2) (REGTØT(J),J=1,NJINK4)                                   902880
C     THE 780 LØØP REARRANGES AND PARTITIØNS THE REGIØN STIFFNESS MATRIX 902890
  102 NJINK = NJINK4/4                                                  902900
      REWIND 2                                                          902910
      DØ 625 INK=1,8                                                    902920
      DØ 626 JAK=1,8                                                    902930
  626 XK11(INK,JAK)=0.0                                                 902940
      DØ 625 KIX=1,M8                                                   902950
      XK12(INK,KIX)=0.0                                                 902960
      XK21(KIX,INK)=0.0                                                 902970
  625 CØNTINUE                                                          902980
      DØ 627 KIX=1,M8                                                   902990
      DØ 627 LAX=1,M8                                                   903000
  627 XK22(KIX,LAX)=0.0                                                 903010
      NREAD=0                                                           903020
      KØUNT=-8                                                          903030
      NJINK3=NJINK-1                                                    903040
      DØ 780 N=1,NJINK                                                  903050
      NREAD=NREAD+1                                                     903060
```

```
      KØUNT=KØUNT+4
      DØ 781 I=1,4
  781 READ(2)  (HØLD(I,J),J=1,NJINK4)
      IF(NREAD.LE.2.ØR.NREAD.GE.NJINK3)GØ TØ 790
      KK=KØUNT+1
      KKK=KØUNT+12
      DØ 785 L=KK,KKK
      IRØW=4*(NREAD-2)
      J=L-4
      DØ 785 K=1,4
      IRØW=IRØW+1
  785 XK22(IRØW,J)=HØLD(K,L)
      GØ TØ 780
  790 IF(NREAD.EQ.1)GØ TØ 791
      IF(NREAD.EQ.2)GØ TØ 792
      IF(NREAD.EQ.NJINK3)GØ TØ 793
      IF(NREAD.EQ.NJINK)GØ TØ 794
  791 DØ 796 I=1,4
      DØ 796 J=1,4
      XK11(I,J)=HØLD(I,J)
      JJ=J+4
  796 XK12(I,J)=HØLD(I,JJ)
      GØ TØ 780
  792 DØ 797 I=1,4
      DØ 797 J=1,4
      XK21(I,J)=HØLD(I,J)
      JJ=J+4
      XK22(I,J)=HØLD(I,JJ)
      JJJ=J+8
      IF(NNT.EQ.2)  GØ TØ 795
      XK22(I,JJ)=HØLD(I,JJJ)
       GØ TØ 797
  795 XK21(I,JJ)=HØLD(I,JJJ)
  797 CØNTINUE
      GØ TØ 780
  793 M11=NJINK4-11
      M4=NJINK4-4
      M8=NJINK4-8
      KRØW=M8-4
      DØ 798 I=1,4
      KRØW=KRØW+1
      KCØL=4
      K8=M8-8
      DØ 798 J=M11,M8
      K8=K8+1
      XK22(KRØW,K8)=HØLD(I,J)
      JJ=J+4
      KK=K8+4
      XK22(KRØW,KK)  =HØLD(I,JJ)
      JJJ=J+8
      KCØL=KCØL+1
  798 XK21(KRØW,KCØL)=HØLD(I,JJJ)
      GØ TØ 780
  794 KEND=NJINK4-8
      KRØW=4
      M4=NJINK4-4
      M7=NJINK4-7
      DØ 799 I=1,4
      KRØW=KRØW+1
      K4=KEND-4
      KCØL=4
```

```
      DØ 799 J=M7,M4
      K4=K4+1
      XK12(KRØW,K4)=HØLD(I,J)
      KCØL=KCØL+1
      JJ=J+4
  799 XK11(KRØW,KCØL)=HØLD(I,JJ)
  780 CØNTINUE
 7703 NSING=NKIV*(NKIV+1)/2
      N=NKIV
      IK=1
      DØ 10 K=1,N
      DØ 10 I=K,N
      XK22(I,K)=(XK22(I,K)+ XK22(K,I))/2.
      XKIV(IK)=XK22(I,K)
   10 IK=IK+1
      CALL SWITCH (XKIV,-NKIV)
      CALL CHASE (XKIV,NKIV,XK21,8,112,NIX)
      IF (NIX.LT.0) GØTØ 8841
      WRITE (10) ((XK21(I,J),J=1,8),I=1,M8    )
      WRITE (10)(( SAVJTC(I), SAVSTP(I)),I=1,NNT)
      DØ 81 J=1,8
      DØ 81 I=1,8
      XK1221(I,J)=0.0
      DØ 81 K=1,NKIV
   81 XK1221(I,J)=XK1221(I,J)+XK12(I,K)*XK21(K,J)
      DØ 82 J=1,8
      DØ 82 I=1,8
   82 XKR(I,J)=XK11(I,J)-XK1221(I,J)
      DØ 650 J=1,7
      K = J+1
      DØ 650 I=K,8
      XKR(I,J) = (XKR(I,J)+XKR(J,I))/2.0
  650 XKR(J,I) = XKR(I,J)
      WRITE (4) ((XKR(I,J),J=1,8),I=1,8)
      IF (NH.NE.0.AND.IBEGIN.NE.1) GØ TØ 691
      WRITE(6,5011)
 5011 FØRMAT(////55X23HREGIØN STIFFNESS MATRIX//14X8HDELTA T17X8HDELTA Z
     11,7X,8HDELTA R1,7X,7HTHETA 1,8X,8HDELTA T2,7X,8HDELTA Z2,7X,8HDELT
     2A R2,7X,7HTHETA 2)
      III=0
      DØ 687 M=1,8
      II=III+1
      III=II+1
      WRITE(6,688)  (LABEL(I),I=II,III),(XKR(M,J),J=1,8)
  688 FØRMAT(/1X,2A4,1X,8(E14.7,1X))
  687 CØNTINUE
  691 CØNTINUE
      DØ 137 J=1,8
      DØ 137 I=1,8
  137 SYM(I,J)=0.0
      INDEC=0
      DØ 138 I=1,8
      DØ 138 J=1,8
      IF(J.NE.I)GØ TØ 138
      IF(XKR(I,J).GE.0.0)GØ TØ 138
      INDEC=1
  138 SYM(I,J)=XKR(I,J)
      IF(INDEC.EQ.0)GØ TØ 151
      IF (NH.NE.0) GØ TØ 151
      WRITE(6,152)
  152 FØRMAT(////- ************************************   WARNING - NEGATI
```

```
   IVES APPEAR ØN MAIN DIAGØNAL. REVISE SIZING    *****************-//)
 151 JJ=2
     N  = 8
     J  = 1
     DØ 42  II=1,7
     M  = JJ
     DØ 43  I=M,N
     ALPH = ABS(SYM(I,J)) - ABS(SYM(J,I))
     IF(ALPH) 47,71,48
  47 IF(SYM(I,J).EQ.0.0) GØTØ 71
     SYM(I,J) = SYM(J,I) / SYM(I,J)
     GØTØ 43
  48 IF(SYM(J,I).EQ.0.0) GØTØ 71
     SYM(I,J) = SYM(I,J) / SYM(J,I)
     GØTØ 43
  71 SYM(I,J) = 1.0
  43 SYM(J,I) = 0.0
     JJ = JJ +1
     J = J+1
  42 CØNTINUE
     IF (NH.NE.0.AND.IBEGIN.NE.1) GØ TØ 692
     WRITE(6,157)
 157 FØRMAT(//56X,21HREGIØN SYMMETRY CHECK/)
     DØ 1730 I=1,8
     WRITE(6,5000) (SYM(I,J),J=1,8)
1730 CØNTINUE
 692 CØNTINUE
     IF (NPRØB.EQ.0) GØ TØ 150
     DØ 819 I=1,4
 819 READ(3)  (XL1(I,J),J=1,NPRØB)
     DØ 818 I=5,8
 818 READ(3)  (XL1(I,J),J=1,NPRØB)
     D = 0.0
     M8 = NJINK4-8
     DØ 817 I=1,M8
 817 READ(3)  (XL2(I,J),J=1,NPRØB)
     CALL CHASE (XKIV,NKIV,XL2,-NPRØB,112,NIX)
     IF (NIX.LT.0) GØTØ 8842
     WRITE (10) ((XL2(I,J),J=1,NPRØB),I=1,M8    )
     NL2=NPRØB
     DØ 205  J=1,NPRØB
     DØ 205  I=1,8
     XK12L2(I,J)=0.0
     DØ 205  K=1,NKIV
 205 XK12L2(I,J)=XK12L2(I,J)+XK12(I,K)*XL2(K,J)
     DØ 206  J=1,NPRØB
     DØ 206  I=1,8
 206 XLR(I,J)=XL1(I,J)-XK12L2(I,J)
     WRITE(8) ((XLR(I,J),J=1,NPRØB),I=1,8)
     IF (NH.NE.0.AND.IBEGIN.NE.1) GØ TØ 150
     WRITE(6,5012)
5012 FØRMAT(//57X,18HREGIØN LØAD MATRIX/)
     DØ 5512 I=1,8
5512 WRITE(6,5000)  (XLR(I,J),J=1,NPRØB)
     GØTØ 150
8841 IERRØR=8841
     NERRØR=30
     GØTØ 150
8797 IERRØR = 8797
     NERRØR=33
     GØ TØ 150
```

```
8842 IERRØR=8842
     NERRØR=31
     GØTØ 150
   1 READ (2) ((XKR(I,J),J=1,8),I=1,8)
     DØ 651 J=1,7
     K = J+1
     DØ 651 I=K,8
     XKR(I,J) = (XKR(I,J)+XKR(J,I))/2.0
 651 XKR(J,I) = XKR(I,J)
     WRITE(4) ((XKR(I,J),J=1,8),I=1,8)
     IF (NPRØB.EQ.0) GØ TØ 150
     READ(3)  ((XLR(I,J),J=1,NPRØB),I=1,8)
     WRITE(8) ((XLR(I,J),J=1,NPRØB),I=1,8)
 150 RETURN
      END
```

```
C ..... RØUTINE **D10      ** ABACUS UPDATED 07/07/72 .....
      SUBRØUTINE SWITCH(A,M)
      DIMENSIØN A(1)
      N = IABS(M)
      IF (N - 2) 190,190,90
   90 L = (N*(N+1)) / 2
      KEY = 1
      LØCK = N/2 + 1
      IF (M) 100,190,160
  100 IF (N - 3) 110,140,110
  110 KKT = 3
      NKF = N - 1
      IMAGE = L
      INTØ = L - 3
      I = 3
      DØ 130  K = 2,LØCK
      DØ 120  IK = KKT,NKF
      X = A(IK)
      A(IK) = A(INTØ)
      A(INTØ) = X
      INTØ = INTØ - I
  120 I = I + 1
      KKT = NKF + K
      NKF = NKF + N - K
      IMAGE = IMAGE - K
      INTØ = IMAGE
  130 I = K
  140 IF (KEY) 150,190,150
  150 KEY = 0
  160 LØV2 = L / 2
      K = L - 2
      DØ 170  I = 3,LØV2
      X = A(I)
      A(I) = A(K)
      A(K) = X
  170 K = K - 1
      IF (KEY) 180,190,180
  180 KEY = 0
      GØ TØ 100
  190 RETURN
       END
```

```
C ..... RØUTINE **D11     ** ABACUS UPDATED 07/07/72 .....
      SUBRØUTINE CHASE(A,MO,Y,NO,MID,NIX)
      REAL A(1),Y(1)
      CØMMØN /WINTER/ INDIC8
      CØMMØN /BØND/ M,L
      CØMMØN /ØPT2/ PRINT
    9 FØRMAT(12H1SØLUTIØN(S)/1H0)
   10 FØRMAT(I5,1P8E15.7/(5X,8E15.7))
      M=MO
      INDIC8=0
      N = IABS(NO)
      IF (NO) 110,100,100
  100 CALL FUTILE(A,M,NIX)
      IF (NIX) 170,110,110
  110 PRINT = 0.0
      IF (PRINT .GT. 0.0)  WRITE(6,9)
      MK1 = 1
      L = 1
      I1 = M
      DØ 160  K = 1,N
      CALL TRIEQ(A,Y(MK1))
      IF (PRINT .GT. 0.) WRITE (6,10) K,(Y(K1), K1 = MK1,I1)
      I1 = I1 + MID
      MK1 = MK1 + MID
  160 CØNTINUE
  170 RETURN
      END
```

```
C ..... RØUTINE **D12      ** ABACUS UPDATED 07/19/72 .....
      SUBRØUTINE FUTILE(A,N,NIX)
      DIMENSIØN A(1)
      DØUBLE PRECISIØN SUM
      EQUIVALENCE (SUN,SUM)
      K1 = 1
      KK = 0
      DØ 210  K = 1,N
      KK = KK + K
      IK = KK
      KK1 = KK - 1
      IF (KK1) 60,50,60
   50 ASSIGN 100 TØ LEAP
      GØ TØ 70
   60 ASSIGN  80 TØ LEAP
   70 I1 = K1
      DØ 140  I = K,N
      SUM = -A(IK)
      GØ TØ LEAP, (80,100)
   80 IJ = I1
      DØ 90 KJ = K1,KK1
      SUM = SUM + A(IJ)*A(KJ)
   90 IJ = IJ + 1
  100 I1 = I1 + I
      IF (I - K) 120,105,120
  105 DENØM = -SUM
      IF (DENØM) 980,980,110
  110 DENØM = -SQRT(DENØM)
      A(IK) = -DENØM
      GØ TØ 130
  120 A(IK) = SUM / DENØM
  130 IK = IK + I
  140 CØNTINUE
      K1 = K1 + K
  210 CØNTINUE
      NIX = 0
  220 RETURN
  980 NIX = -K
      GØ TØ 220
       END
```

```
C ..... RØUTINE **D13     ** ABACUS UPDATED 07/19/72 .....
      SUBRØUTINE TRIEQ(A,Y)
      REAL A(1),Y(1)
      CØMMØN /WINTER/INDIC8
      CØMMØN /BØND/ M,L
      EQUIVALENCE (SUN,SUM)
      L1 = L
      MM1 = M - 1
      MML = M - L1
      IF (INDIC8) 130,100,100
  100 Y(L1) = Y(L1) / A(L1)
      I1 = L1
      II = I1
      IF (MML) 105,125,105
  105 DØ 120  I = L1,MM1
      I1 = I1 + I
      SUM = -Y(I+1)
      IJ = I1
      DØ 110  J = L1,I
      SUM = SUM + A(IJ)*Y(J)
  110 IJ = IJ + 1
      II = IJ
  120 Y(I+1) = -SUM / A(II)
  125 IF (INDIC8) 170,140,170
  130 II = ( ( MML + 1 ) * ( M + L1 ) )  /  2
  140 I = M
  145 Y(I) = Y(I) / A(II)
      II = II - I
      I = I - 1
      IF (I - L1) 170,150,150
  150 SUN = -Y(I+1)
      IJ = II + L1
      DØ 160  J = L1,I
      Y(J) = Y(J) + SUN*A(IJ)
  160 IJ = IJ + 1
      GØ TØ 145
  170 RETURN
       END
```

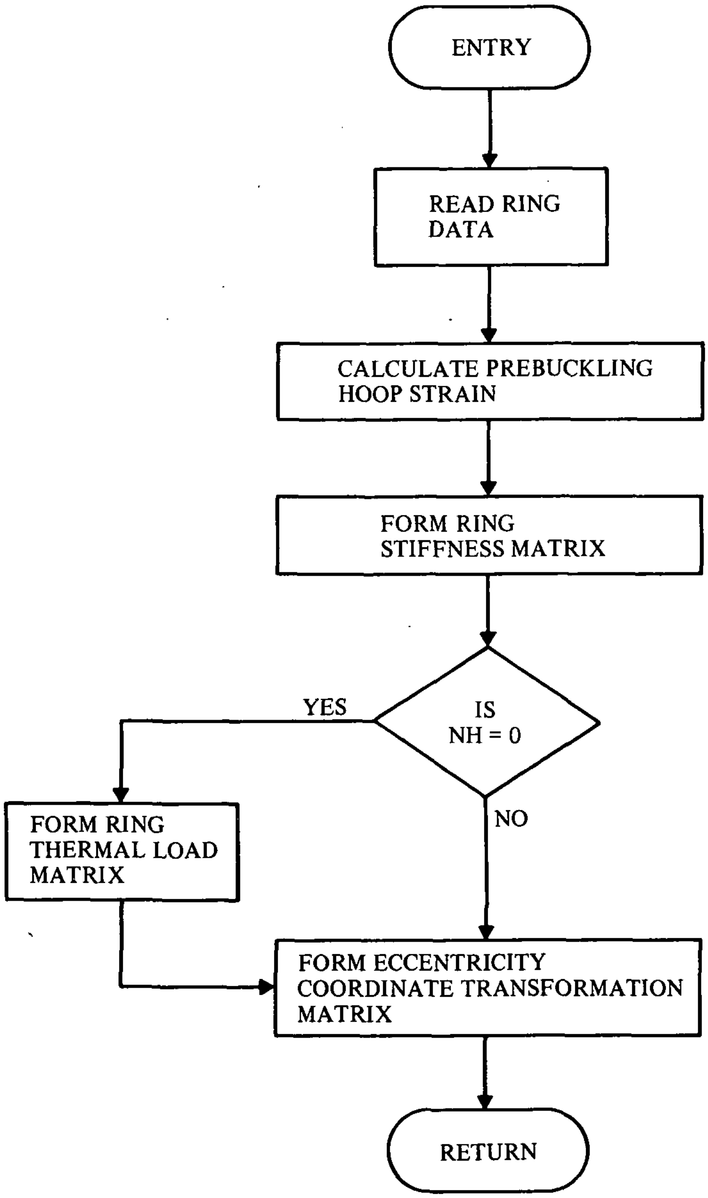
SUBROUTINE RINGER

This subroutine reads the discrete ring geometric data, and temperatures, and forms the ring stiffness and thermal load matrices. These matrices are passed back to either of subroutines REGMAT or STRMAT (see next) as necessary, for incorporation into the region or structure matrices, respectively. If the present pass is a nonlinear one, the effects of prebuckling hoop strain are considered, and the load calculations are omitted.

The calculations in RINGER account for the eccentricity of the ring centroid from the base shell wall, and the offset of the ring centroid from the shear center.

FORTRAN CODE	ENGINEERING SYMOBLS (REF. 1)
RNGTOT MATRIX	$\left[k_R\right]$
TDEL MATRIX	$\left[T_\Delta\right]$
RNGLOD MATRIX	$\left[\ell_R\right]$
RC	r_c
RS	r_s
XC	x_c
YC	x_s

RINGER



ENTRY
READ RING DATA
CALCULATE PREBUCKLING HOOP STRAIN
FORM RING STIFFNESS MATRIX
IS NH = 0
YES
NO
FORM RING THERMAL LOAD MATRIX
FORM ECCENTRICITY COORDINATE TRANSFORMATION MATRIX
RETURN

```
C ..... RØUTINE ** RINGER ** ABACUS UPDATED 06/18/72 .....
      SUBRØUTINE RINGER (Q,XN,RNGTØT,RNGLØD,J,ADUS,BADUS,JTIC,JSTØP,
     1                   JTNØ,KBC,XNL,MFLG,NSEG)
      INTEGER Q,XN
      CØMMØN /ARING/ NRING(28),AMAT(30,4),IRLC(28)
      DIMENSIØN RNGTØT(4,4),RNGLØD(4,28),TDEL(4,4),XKTØT(4,4),XL(4)
      DIMENSIØN ADUS(30),BADUS(30),JTIC(30),JSTØP(30),JTNØ(28),XNL(2)
      X1 = XNL(1)
      X2 = XNL(2)
      IF (Q.EQ.1) GØ TØ 212
      READ(5,213) JTNØ(J),EA,EIY,EIXY,GJ,EIX,ALPR,RC,XC,YC,XBAR,YBAR,XI,
     1            XØ,TI,TØ,TF,IRLC(J),   RØJ,ENTHJ,ENTHK
  213 FØRMAT(I2,5E14.7/6E12.5/5E14.7,I2/3E14.7)
      AMN = (TI-TØ)/(XI-XØ)
      BN = ((TØ-TF)*XI-(TI-TF)*XØ)/(XI-XØ)
      WRITE(1) JTNØ(J),EA,EIY,EIXY,GJ,EIX,ALPR,RC,XC,YC,XBAR,YBAR,
     1         AMN,BN,IRLC(J),   RØJ,ENTHJ,ENTHK
      WRITE(6,300) JTNØ(J),EA,EIY,EIXY,GJ,EIX,ALPR,RC,XC,YC,XBAR,YBAR,
     1             XI,XØ,TI,TØ,TF,   RØJ
  300 FØRMAT(/55X,-RING AT JØINT NØ. -,I2//- EA =-,1PE12.5,6X,-EIY =-,
     1 1PE12.5,5X,-EIXY =-,1PE12.5,4X,-GJ =-,1PE12.5,6X,-EIX =-,1PE12.5,
     2 5X,-ALPR =-,1PE12.5/- RC =-,1PE12.5,6X,-XC =-,1PE12.5,6X,-YC =-,
     3 1PE12.5,6X,-XBAR =-,1PE12.5,4X,-YBAR =-,1PE12.5,4X,-XI =-,
     4 1PE12.5/- XØ =-,1PE12.5,6X,-TI =-,1PE12.5,6X,-TØ =-,1PE12.5,6X,
     5 -TFREE =-,1PE12.5,3X,                     -RØ =-,1PE12.5)
      IF (KBC.NE.0) WRITE(6,301) ENTHJ,ENTHK
  301 FØRMAT(- NTHETA1 =-,1PE12.5,8X,- NTHETA2 =-,1PE12.5)
      GØ TØ 211
  212 READ(1) JTNØ(J),EA,EIY,EIXY,GJ,EIX,ALPR,RC,XC,YC,XBAR,YBAR,
     1        AMN,BN,IRLC(J),   RØJ,ENTHJ,ENTHK
  211 CØNTINUE
      IF (KBC.EQ.0) GØ TØ 100
      EPSIL1=ENTHJ/EA
      EPSIL2=ENTHK/EA
      GØ TØ 101
  100 K = JTNØ(J)
      IF (MFLG.EQ.2) GØ TØ 102
      EPSIL1=AMAT(K,1)
      EPSIL2=AMAT(K,2)
      GØ TØ 101
  102 EPSIL1=AMAT(K,3)
      EPSIL2=AMAT(K,4)
  101 CØNTINUE
      RS = RC+XC
      AM = XN
      AM2 = AM*AM
      AM4 = AM2*AM2
      RCS = RC*RS
      RC2 = RC*RC
      RS2 = RS*RS
      RS3 = RS2*RS
      RCS3 = RCS*RS2
      XC2 = XC*XC
      YC2 = YC*YC
      TWØPI = 2.0*3.1415927
      EPSIL=(X1*EPSIL1+X2*EPSIL2)*RC/RØJ
      EAPS = EA*EPSIL
      RNGTØT(1,1) = 1.0/RCS*(EA*(XC2*AM4/RS2-2.0*XC*AM2/RS+1.0)+
     1              EIY/RC2*(AM4-2.0*AM2+1.0))
     2              +EAPS*AM2*RC/RS3-EAPS*RC/RS3
```

```
      RNGTØT(2,1) = 1.0/RCS*(EA*YC*AM2*(XC*AM2/RS2-1.0/RS)+EIY*YC*AM2/  3300590
     1              (RC2*RS)*(AM2-1.0)+EIXY*AM2/RCS*(AM2-1.0))         3300600
      RNGTØT(3,1) = EA*AM/RS2*(-XC*AM2/RS+1.0)                         3300620
      RNGTØT(4,1) = 1.0/RCS*(EA*YC*(XC*AM2/RS-1.0)+EIY*YC/RC2*         3300640
     1              (AM2-1.0)+EIXY/RC*(AM2-1.0))                       3300650
     2              -EAPS*AM2*YC/RS2+EAPS*YC/RS2                       3300660
      RNGTØT(1,2) = RNGTØT(2,1)                                        3300670
      RNGTØT(2,2) = AM4/RCS3*(EA*YC2+EIY*YC2/RC2+EIX+2.0*EIXY*YC/RC)+  3300680
     1              GJ*AM2/(RS2*RS2)                                   3300690
     2              +AM2/RCS*EAPS                                      3300700
      RNGTØT(3,2) = -EA*YC*AM2*AM/(RS2*RS)                             3300710
      RNGTØT(4,2) = AM2/(RS2*RC)*(YC2*(EA+EIY/RC2)+EIX+2.0*EIXY*YC/RC  3300730
     1              +GJ*RC/RS)                                         3300740
     2              +AM2/RCS*(EAPS*XC)                                 3300750
      RNGTØT(1,3) = RNGTØT(3,1)                                        3300760
      RNGTØT(2,3) = RNGTØT(3,2)                                        3300770
      RNGTØT(3,3) = EA*AM2*RC/(RS2*RS)                                 3300780
      RNGTØT(4,3) = -EA*YC*AM/RS2                                      3300800
      RNGTØT(1,4) = RNGTØT(4,1)                                        3300820
      RNGTØT(2,4) = RNGTØT(4,2)                                        3300830
      RNGTØT(3,4) = RNGTØT(4,3)                                        3300840
      RNGTØT(4,4) = 1.0/RCS*(YC2* EA+EIY*YC/RC+EIX+2.0*EIXY*YC/RC)+     330085
     1              GJ*AM2/RS2                                         3300860
     2              +1.0/RCS*EPSIL*(EA*(-YC2)+(EIY+EIX)*AM2-EIX)       3300870
      IF (Q.EQ.1) GØ TØ 400                                            3300880
      TEM1 = EA*ALPR*(AMN*XC+BN)/RS                                    3300890
      RNGLØD(1,J) = TEM1                                               3300900
      RNGLØD(2,J) = 0.0                                                3300910
      RNGLØD(3,J) = 0.0                                                3300920
      RNGLØD(4,J) = -TEM1*YC-EIXY*ALPR*AMN/RS                          3300930
  400 CØNTINUE                                                         3300940
      XBRS = 1.0-XBAR/RS                                               3300950
      TDEL(1,1) = 0.0                                                  3300960
      TDEL(2,1) = 0.0                                                  3300970
      TDEL(3,1) = -1.0/XBRS                                            3300980
      TDEL(4,1) = 0.0                                                  3300990
      TDEL(1,2) = 0.0                                                  3301000
      TDEL(2,2) = -1.0                                                 3301010
      TDEL(3,2) = -AM*YBAR/(RS*XBRS)                                   3301020
      TDEL(4,2) = 0.0                                                  3301030
      TDEL(1,3) = -1.0                                                 3301040
      TDEL(2,3) = 0.0                                                  3301050
      TDEL(3,3) = -AM*XBAR/(RS*XBRS)                                   3301060
      TDEL(4,3) = 0.0                                                  3301070
      TDEL(1,4) = -YBAR                                                3301080
      TDEL(2,4) = +XBAR                                                3301090
      TDEL(3,4) = 0.0                                                  3301100
      TDEL(4,4) = -1.0                                                 3301110
      DØ 813 L=1,4                                                     3301120
      DØ 813 M=1,4                                                     3301130
      XKTØT(L,M) = 0.0                                                 3301140
      DØ 813 N=1,4                                                     3301150
  813 XKTØT(L,M) = XKTØT(L,M)+RNGTØT(L,N)*TDEL(N,M)                    3301160
      DØ 814 L=1,4                                                     3301170
      DØ 814 M=1,4                                                     3301180
      RNGTØT(L,M) = 0.0                                                3301190
      DØ 814 N=1,4                                                     3301200
  814 RNGTØT(L,M) = RNGTØT(L,M)+TDEL(N,L)*XKTØT(N,M)                   3301210
      IF (Q.EQ.1) GØ TØ 401                                            3301220
      DØ 815 L=1,4                                                     3301230
      XL(L) = 0.0                                                      3301240
```

```
      DØ 815 N=1,4
  815 XL(L) = XL(L)+TDEL(N,L)*RNGLØD(N,J)
      DØ 816 L=1,4
  816 RNGLØD(L,J) = XL(L)
  401 CØNTINUE
      DØ 1100 L=1,NSEG
      IF (JTNØ(J).EQ.JTIC(L)) GØ TØ 1105
 1100 CØNTINUE
      GØ TØ 1107
 1105 M = JTIC(L)
      RMULT = ADUS(M)*TWØPI
      GØ TØ 1111
 1107 DØ 1101 L=1,NSEG
      IF (JTNØ(J).EQ.JSTØP(L)) GØ TØ 1106
 1101 CØNTINUE
 1106 M = JSTØP(L)
      RMULT = RADUS(M)*TWØPI
 1111 CØNTINUE
      DØ 820 L=1,4
      DØ 820 M=1,4
  820 RNGTØT(L,M) = RNGTØT(L,M)*RMULT
      IF (Q.EQ.1) GØ TØ 402
      DØ 821 L=1,4
  821 RNGLØD(L,J) = RNGLØD(L,J)*RMULT
  402 RETURN
      END
```

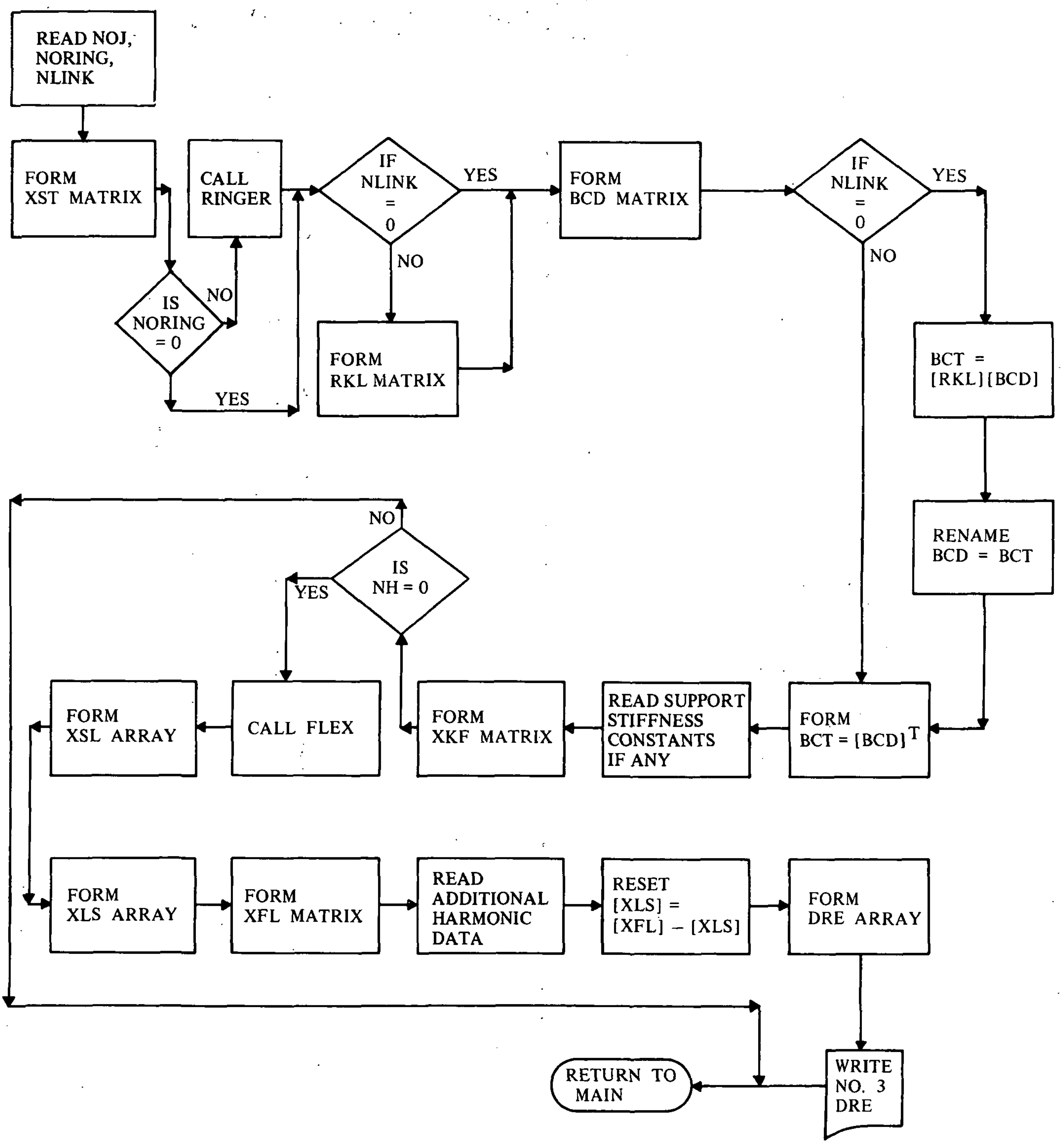
SUBROUTINE STRMAT

The region stiffness matrices, XKR, and the region load matrices, XLR, are passed from REGMAT to STRMAT via Tape #4 and Tape #8, and are placed in the XKSTOT array and the XLSTOT array, respectively. A matrix, BCD, is formed to represent the boundary conditions, and, if kinematic links occur between regions, the RKL matrix is developed to represent this situation. The subroutine RINGER is again called for discrete ring matrices. In passes other than the first pass, first cycle, the load calculations are not performed.

As a result of appropriate matrix operations, a reduced structure stiffness matrix is formed. In passes other than the first pass, first cycle, STRMAT terminates here. In the first pass, first cycle, the following calculations are made. Subroutine FLEX, a routine identical to SREVN2 (except for being in single precision) with the name changed due to the structure of the OVERLAY option, is called to invert the structure stiffness matrix thus producing A, the flexibility matrix for the structure. The region end deflection array, DRE, is produced as the result of another set of matrix operations.

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1)
BCD MATRIX	$\left[BC\right]$
BCT MATRIX	$\left[BC\right]^T$
XST MATRIX	$\left[\hat{K}\right]_T$
XKF MATRIX	$\left[\hat{K}\right]_F$
A MATRIX	$\left[\hat{A}\right]_F$
XSL MATRIX	$\left[\hat{L}\right]_T$
XLS ARRAY	$\left\{\hat{L}\right\}_F$
XFL ARRAY	$\left\{\hat{F}\right\}_F$
DRE ARRAY	$\left\{\Delta\right\}_T$

STRMAT


READ NOJ, NORING, NLINK
FORM XST MATRIX
CALL RINGER
IS NORING = 0
NO
YES
IF NLINK = 0
YES
NO
FORM RKL MATRIX
FORM BCD MATRIX
IF NLINK = 0
YES
NO
BCT = [RKL] [BCD]
RENAME BCD = BCT
FORM BCT = [BCD] T
READ SUPPORT STIFFNESS CONSTANTS IF ANY
FORM XKF MATRIX
IS NH = 0
NO
YES
CALL FLEX
FORM XSL ARRAY
FORM XLS ARRAY
FORM XFL MATRIX
READ ADDITIONAL HARMONIC DATA
RESET [XLS] = [XFL] – [XLS]
FORM DRE ARRAY
WRITE NO. 3 DRE
RETURN TO MAIN

```
C..... ROUTINE **D14    /** ABACUS UPDATED 07/19/72 .....
      SUBROUTINE STRMAT
      INTEGER SAVJTC,SAVSTP,Q,THICK
      INTEGER XN1,XN
      DOUBLE PRECISION SAVTIC,TIC,PHI,STOP,RESTOP,RTICK
      COMMON STORY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)
      COMMON TADUS(30),UADUS(30),SAVTIC(900)
      COMMON XN,TEFREE,TIC,PHI,STOP,RESTOP,RTICK,G1,XNL(2),NH
      COMMON NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)
      COMMON JRSTOP(30),NREG,NMPT,NRC,NSC,NIX,IERROR,KGEOM,IGEOM,ISTTAB
      COMMON KELVIN,IBEGIN,NPROB,NSEG,NERROR,Q,THICK,NOJS,NLINKS,NLCASE
      COMMON NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS
      COMMON /ARING/ NRING(28),AMAT(30,4),IRLC(28)
      DIMENSION SCLA(128),LOC(128)
      DIMENSION ICOL(10)
      DIMENSION RKL(120,120),OPEN(4,4)
      DIMENSION DLP(4),BCD(124,124),TEMP(124),BCT(124),XKF(128),BC(128)
      DIMENSION A(124,124),XSL(124,2),XFL(124,2),DRE(128,2),BCA(128)
      DIMENSION XKR(8,8),XSTR(128),XLS(128,2),XLR(8,2)
      DIMENSION XST(124,124),XSTBC(124,124),TEMP1(124)
      DIMENSION RNGTOT(4,4),RNGLOD(4,28),JTNO(28)
      DIMENSION COLTTL(2)
      EQUIVALENCE (XST(1),BCD(1),A(1),XSTBC(1),RKL(1),XLS(1))
      EQUIVALENCE (XSTR(1),XKF(1),XFL(1),XSL(1),DRE(1),SCLA(1),
     1            TEMP(1),OPEN(1))
      EQUIVALENCE (XKR(1),XLR(1),BC(1),BCT(1),BCA(1),TEMP1(1),LOC(1))
      DATA COLTTL/4H  CO,4HLUMN/
      REWIND  2
      REWIND  3
      REWIND  4
      REWIND  8
      REWIND  9
      REWIND 14
      REWIND 15
    1 FORMAT(1H ,8(E14.7,2X)/(3X,8(E14.7,2X)))
  101 FORMAT (3I5,16A4)
      WRITE(6,1726)
 1726 FORMAT(1H1)
      IF (NPROB.EQ.0.AND.NH.NE.0) GO TO 1700
      READ(5,101) NOJ,NORING,NLINK
      NOJS = NOJ
      NLINKS = NLINK
      NRINGS = NORING
      GO TO 1701
 1700 NOJ = NOJS
      NLINK = NLINKS
      NORING = NRINGS
 1701 CONTINUE
      NH4=4
      NH8=8
      NJTNH4=NOJ*NH4
      DO 102  J=1,NJTNH4
      DO 102  I=1,NJTNH4
  102 XST(I,J)=0.0
      DO 100 NR=1,NREG
      READ(4) ((XKR(I,J),J=1,8),I=1,8)
      J1=JRTIC(NR)
      J2=JRSTOP(NR)
      II=4*(J1-1)
  450 JJ=4*(J2-1)+1
```

```
      II=II+1
      DØ 460 JK=1,4
      GØ TØ (451,452,453,454),JK
  451 IX=II
      IND=II
      DØ 461 I=1,4
      DØ 461 J=1,4
  461 ØPEN(I,J)=XKR(I,J)
      GØ TØ 455
  452 IX=II
      IND=JJ
      DØ 462 I=1,4
      DØ 462 J=1,4
  462 ØPEN(I,J)=XKR(I,J+4)
      GØ TØ 455
  453 IX=JJ
      IND=II
      DØ 463 I=1,4
      DØ 463 J=1,4
  463 ØPEN(I,J)=XKR(I+4,J)
      GØ TØ 455
  454 IX=JJ
      IND=JJ
      DØ 464 I=1,4
      DØ 464 J=1,4
  464 ØPEN(I,J)=XKR(I+4,J+4)
  455 DØ 456 I=1,4
      JX=IND
      DØ 457 J=1,4
      XST(IX,JX)=XST(IX,JX)+ØPEN(I,J)
  457 JX=JX+1
  456 IX=IX+1
  460 CØNTINUE
  100 CØNTINUE
      IF (NØRING.EQ.0) GØ TØ 1170
      MFLG = 2
      DØ 1211 J=1,NØRING
      CALL RINGER (Q,XN,RNGTØT,RNGLØD,J,SADUS,UADUS,JRTIC,JRSTØP,JTNØ,
     1             KBC,XNL,MFLG,NREG)
      JT = 4*(JTNØ(J)-1)
      DØ 1220 I=1,4
      DØ 1220 IK=1,4
 1220 XST(JT+I,JT+IK) = XST(JT+I,JT+IK)+RNGTØT(I,IK)
 1211 CØNTINUE
      IF (Q.NE.5) GØ TØ 1170
      WRITE(6,300)
  300 FØRMAT(///)
      READ(5,2000)
 2000 FØRMAT(1X)
 1170 CØNTINUE
      DØ 107 I=1,NJTNH4
  107 WRITE (2)  (XST(I,J),J=1,NJTNH4)
      REWIND 2
      REWIND 4
      IF (NH.NE.0) GØ TØ 3108
C  GENERATIØN ØF BC BØUNDARY CØNDITIØN SCRAMBLING MATRIX
      WRITE(6,347) NØJ,NLINK
  347 FØRMAT(////51X30HINPUT DATA FØR REGIØN CØUPLING///31X24HNUMBER ØF
     1REGIØN JØINTS ,I3,14X26HNUMBER ØF KINEMATIC LINKS ,I3///44X6HREGIØ
     2N11X8HJØINT(I)11X8HJØINT(J)//)
      DØ 348 I=1,NREG
```

```
      KTIC=JRTIC(I)
      KSTØP=JRSTØP(I)
      WRITE(6,349) I,KTIC,KSTØP
  349 FØRMAT(46X,I2,2(16X,I3))
  348 CØNTINUE
      IF(NLINK.EQ.0) GØ TØ 3108
       DØ 756 I=1,NJTNH4
       DØ 756 J=1,NJTNH4
  756 RKL(I,J)=0.0
      DØ 757 I = 1,NJTNH4
  757 RKL(I,I) = 1.0
      DØ 789 I=1,4
       DØ 789 J=1,4
  789 ØPEN(I,J)=0.0
      ØPEN(2,2) = 1.0
      ØPEN(3,3) = 1.0
      ØPEN(4,4) = 1.0
      WRITE(6,1824)
 1824 FØRMAT(//60X,12HREGIØN LINKS//43X,8HJØINT(J),5X,8HJØINT(I),
     15X,20HANGLE ØF ØRIENTATIØN)
      DØ 502 NRIG=1,NLINK
      READ(5,503) JD,JI,CØTAN
  503 FØRMAT(2I2,E14.7)
      WRITE(6,1828) JD,JI,CØTAN
 1828 FØRMAT(46X,I2,11X,I2,11X,E14.7)
      CØTAN = CØS(CØTAN)/SIN(CØTAN)
      ØPEN(1,1) = SADUS(JD) / SADUS(JI)
      ØPEN(2,4) = - (SADUS(JD)-SADUS(JI))
      ØPEN(3,4) = - ØPEN(2,4)* CØTAN
      IXX= JD*4-3
      DØ 504 I=1,4
      JXX= JI*4-3
      DØ 505 J=1,4
      RKL(IXX,JXX)=ØPEN(I,J)
  505 JXX=JXX+1
  504 IXX=IXX+1
  502 CØNTINUE
      READ(5,2000)
      NTRKL = 15
      DØ 781 I=1,NJTNH4
  781 WRITE(15) (RKL(I,J),J=1,NJTNH4)
      REWIND 15
 3108 CØNTINUE
      IF (LINPUT.EQ.0) GØ TØ 3200
      DØ 108 J=1,NJTNH4
      DØ 108 I=1,NJTNH4
  108 RCD(I,J)=0.0
      ICR =1
      WRITE(6,2372)
 2372 FØRMAT(//////57X19HBØUNDARY CØNDITIØNS//30X5HJØINT5X7HDELTA T,5X,7
     1HDELTA Z,5X,7HDELTA R,5X,7H THETA ,7X,11HANGLE ALPHA)
      DØ 109 J=1,NØJ
      READ (5,110) JN,DLP(1),DLP(2),DLP(3),DLP(4),ANGLE
  110 FØRMAT  (I2,4F2.0,E14.1)
      I1 = DLP(1)
      I2 = DLP(2)
      I3 = DLP(3)
      I4 = DLP(4)
      WRITE(6,2373) JN,I1,I2,I3,I4,ANGLE
 2373 FØRMAT(/31X,I3,9X,I2,10X,I2,10X,I2,10X,I2, 7X,E14.7)
      I1  = (4*JN)-3
```

```
      DØ 121 I=1,4
      IF(DLP(I)-1.0) 113,114,115
  115 IF(DLP(I)-2.0) 116,116,117
  114 BCD(II,ICR)=1.0
      GØTØ 118
  116 BCD(II,ICR)=SIN(ANGLE)
      BCD(II+1,ICR)= -CØS(ANGLE)
      GØTØ 118
  117 BCD(II-1,ICR)=CØS(ANGLE)
      BCD(II,ICR)=SIN(ANGLE)
  118 ICR=ICR+1
  113 II=II+1
  121 CØNTINUE
  109 CØNTINUE
      READ(5,2000)
      ICR=ICR-1
      NZ=ICR
      IF(NLINK.EQ.0) GØ TØ 3124
      DØ 783 N=1,NJTNH4
      READ(NTRKL) (TEMP(M),M=1,NJTNH4)
      DØ 782 J=1,NZ
      BCT(J)=0.0
      DØ 782 I=1,NJTNH4
  782 BCT(J)=BCT(J)+TEMP(I)*BCD(I,J)
  783 WRITE (4)  (BCT(L),L=1, NZ)
      REWIND NTRKL
      REWIND 4
      DØ 126 M=1,NJTNH4
  126 READ(4) (BCD(M,N),N=1,NZ)
C     AT THIS PØINT THE BCD ARRAY IS THE PRØDUCT ØF RKL AND BCD ARRAYS
 3124 CØNTINUE
      NBCT = 3
      DØ 124 J=1,NZ
  124 WRITE (3)  (BCD(I,J),I=1,NJTNH4)
      DØ 125 I=1,NJTNH4
  125 WRITE (3)  (BCD(I,J),J=1,NZ)
      REWIND 3
      WRITE(14) ((BCD(I,J),J=1,NZ),I=1,NJTNH4)
      DØ 3300 J=1,NZ
 3300 WRITE(14) (BCD(I,J),I=1,NJTNH4)
      REWIND 4
      GØ TØ 3201
 3200 READ(14) ((BCD(I,J),J=1,NZ),I=1,NJTNH4)
 3201 CØNTINUE
      DØ 180  L=1,NJTNH4
      READ (2) (XSTR(J),J=1,NJTNH4)
      DØ 184  M=1,NZ
      TEMP1(M) = 0.0
      DØ 181  N=1,NJTNH4
  181 TEMP1(M) = TEMP1(M)+XSTR(N)*BCD(N,M)
  184 CØNTINUE
      WRITE(4) (TEMP1(I),I=1,NZ)
  180 CØNTINUE
      REWIND 4
      DØ 183  II=1,NJTNH4
  183 READ (4) (XSTBC(II,JJ),JJ=1,NZ)
      REWIND 4
      DØ 182  N=1,NZ
      READ(NBCT) (BCT(J),J=1,NJTNH4)
      DØ 185  M=1,NZ
      XKF(M)=0.0
```

```
      DØ 186  K=1,NJTNH4                                                1502450
  186 XKF(M)=XKF(M)+BCT(K)*XSTBC(K,M)                                   1502460
  185 CØNTINUE                                                          1502470
      WRITE (4) (XKF(I),I=1,NZ)                                         1502480
      IF (NLCASE.NE.1.ØR.XN1.NE.0.0.ØR.NH.NE.0) GØ TØ 188               1502490
      WRITE(11) (XKF(I),I=1,NZ)                                         1502510
      GØ TØ 182                                                         1502540
  188 CØNTINUE                                                          1502550
      IF (NLCASE.EQ.1.AND.XN.EQ.0.0) GØ TØ 182                          1502560
      IF ((XN.EQ.XN1.AND.NPASS.EQ.2).ØR.(NH.NE.0.AND.NPASS.EQ.1))       1502570
     1     WRITE(11) (XKF(I),I=1,NZ)                                    1502580
  182 CØNTINUE                                                          1502590
      NBCT = 14                                                         1502600
      REWIND 2                                                          1502610
      REWIND 4                                                          1502620
      DØ 187 I=1,NZ                                                     1502630
  187 READ(4) (A(I,J),J=1,NZ)                                           1502640
      IF (IBEGIN.EQ.0) GØ TØ 1750                                       1502650
      WRITE(6,1726)                                                     1502660
      WRITE(6,2365)                                                     1502670
 2365 FØRMAT(50X,29H THE REDUCED STIFFNESS MATRIX/)                     1502680
      NUMBER = 2                                                        1502690
      JJ = 0                                                            1502700
      JJJ = 0                                                           1502710
 1725 JJ = JJJ + 1                                                      1502720
      JJJ = JJJ + 8                                                     1502730
      MM = 8                                                            1502740
      IF (JJJ.GT.NZ) MM=8-(JJJ-NZ)                                      1502750
      MMM = JJ                                                          1502760
      IF(JJJ.GT.NZ) JJJ=NZ                                              1502770
      DØ 1721 M=1,MM                                                    1502780
      ICØL(M)=MMM                                                       1502790
 1721 MMM = MMM + 1                                                     1502800
      NUMBER = NUMBER + 3                                               1502810
      WRITE(6,1729) ((CØLTTL,ICØL(M)),M=1,MM)                           1502820
 1729 FØRMAT(/10H   RØW    ,8(2A4,1X,I3,3X)/)                           1502830
      DØ 1722 I=1,NZ                                                    1502840
      NUMBER = NUMBER + 1                                               1502850
      WRITE(6,1728)I,(A(I,J),J=JJ,JJJ)                                  1502860
 1728 FØRMAT(3X,I3,4X,8(E14.7,1X))                                      1502870
      IF(NUMBER.LT.55) GØ TØ 1722                                       1502880
      NUMBER = 3                                                        1502890
      WRITE(6,1726)                                                     1502900
      WRITE(6,1729) ((CØLTTL,ICØL(M)),M=1,MM)                           1502910
 1722 CØNTINUE                                                          1502920
      IF(JJJ.NE.NZ) GØ TØ 1725                                          1502930
 1750 CØNTINUE                                                          1502940
      IF (NH.NE.0.ØR.KBC.NE.0) GØ TØ 7                                  1502950
      DDC = 0.0                                                         1502960
      RØR = 0.0                                                         1502970
      CALL FLEX (A,NZ,SCLA,124,NIX)                                     1502980
      IF (NIX.NE.0) GØ TØ 8777                                          1502990
      DØ 804 L=1,NJTNH4                                                 1503000
      READ(3) (BC(I),I=1,NZ)                                            1503010
      DØ 716 M=1,NZ                                                     1503020
      TEMP(M) = 0.0                                                     1503030
      DØ 805 N=1,NZ                                                     1503040
  805 TEMP(M) = TEMP(M) + BC(N)*A(N,M)                                  1503050
  716 CØNTINUE                                                          1503060
      WRITE (2) (TEMP(I),I=1,NZ)                                        1503070
  804 CØNTINUE                                                          1503080
```

```
      REWIND 2                                                          1503090
      REWIND 3                                                          1503100
      DØ 991 J=1,NPRØB                                                  1503110
      DØ 991 I=1,NJTNH4                                                 1503120
  991 XSL(I,J) = 0.0                                                    1503130
 1001 DØ 777 NR=1,NREG                                                  1503140
      J1 = JRTIC(NR)                                                    1503150
      J2 = JRSTØP(NR)                                                   1503160
      READ(8) ((XLR(I,J),J=1,NPRØB),I=1,NH8)                            1503170
      DØ 777 N2 = 1,2                                                   1503180
      GØTØ (11,12),N2                                                   1503190
   11 II = (J1-1)*NH4+1                                                 1503200
      III= II+NH4-1                                                     1503210
      GØTØ 3                                                            1503220
   12 II = (J2-1)*4+1                                                   1503230
      III= II+NH4-1                                                     1503240
    3 DØ 777 J=1,NPRØB                                                  1503250
      I=0                                                               1503260
      IF(N2.EQ.2) I=NH4                                                 1503270
      DØ 777 IL=II,III                                                  1503280
      I=I+1                                                             1503290
  777 XSL(IL,J) = XSL(IL,J)+XLR(I,J)                                    1503300
      IF (NØRING.EQ.0) GØ TØ 1150                                       1503310
      DØ 1225 J=1,NØRING                                                1503320
      JT = 4*(JTNØ(J)-1)                                                1503330
      DØ 1226 I=1,4                                                     1503340
      DØ 1226 IK=1,NPRØB                                                1503350
      IF (IK.EQ.1.AND.IRLC(J).EQ.2) GØ TØ 1226                          1503311
      XSL(JT+I,IK) = XSL(JT+I,IK)+RNGLØD(I,J)                           1503320
 1226 CØNTINUE                                                          1503321
 1225 CØNTINUE                                                          1503370
 1150 CØNTINUE                                                          1503380
      DØ 876 N=1,NZ                                                     1503390
      READ(3) (BCT(J),J=1,NJTNH4)                                       1503400
      DØ 717 M=1,NPRØB                                                  1503410
      XLS(N,M) = 0.0                                                    1503420
      DØ 806 K=1,NJTNH4                                                 1503430
  806 XLS(N,M) = XLS(N,M) + BCT(K)*XSL(K,M)                             1503440
  717 CØNTINUE                                                          1503450
  876 CØNTINUE                                                          1503460
      REWIND 3                                                          1503470
      DØ 301 J=1,NPRØB                                                  1503480
      DØ 301 I=1,NZ                                                     1503490
  301 XFL(I,J) = 0.0                                                    1503500
      READ(5,302)  LINLØD,(STØRY(I),I=1,16)                             1503510
  302 FØRMAT(I4,16A4)                                                   1503520
      IF(LINLØD.EQ.0)  GØ TØ 303                                        1503530
      WRITE(6,341)                                                      1503540
  341 FØRMAT(1H1///57X,19HEXTERNAL LINE LØADS///36X,14HPRØBLEM NUMBER,7X 1503550
     120HPØINT ØF APPLICATIØN,7X,12HAPPLIED LØAD//)                     1503560
      DØ 304 N=1,LINLØD                                                 1503570
      READ(5,305) JEXT2,JEXT1,XFL(JEXT1,JEXT2)                          1503580
  305 FØRMAT(2I5,E14.7)                                                 1503590
      WRITE(6,342) JEXT2,JEXT1,XFL(JEXT1,JEXT2)                         1503600
  342 FØRMAT(41X,I3,22X,I3,15X,E14.7)                                   1503610
  304 CØNTINUE                                                          1503620
  303 CØNTINUE                                                          1503630
      READ(5,2000)                                                      1503640
      DØ 811 J=1,NPRØB                                                  1503650
      DØ 811 I=1,NZ                                                     1503660
      XLS(I,J)=XFL(I,J)-XLS(I,J)                                        1503670
```

```
      IF(J.EQ.2)XLS(I,J)=XLS(I,J)+XFL(I,1)
  811 CØNTINUE
      REWIND 3
      DØ 812 J=1,NJTNH4
      READ (2) (BCA(K),K=1,NZ)
      DØ 813 M=1,NPRØB
      DRE(J,M)=0.0
      DØ 813 N=1,NZ
  813 DRE(J,M)=DRE(J,M)+BCA(N)*XLS(N,M)
  812 CØNTINUE
      WRITE(6,1726)
      WRITE(6,2368)
 2368 FØRMAT(31X,70HTHE EXPANDED REGIØN JØINT DISPLACEMENT MATRIX (REGIØ
     1N END DEFLECTIØNS))
      WRITE(6,1770)
 1770 FØRMAT(//14X,5HJØINT,14X,7HPRØBLEM,13X,7HDELTA T,13X,7HDELTA Z,13X
     1,7HDELTA R,11X,11HØMEGA-THETA)
      NUMBER = 4
      KK=-3
      DØ 1735 J=1,NØJ
      NUMBER = NUMBER + NPRØB + 1
      IF(NUMBER.LT.56) GØ TØ 1745
      WRITE(6,1726)
      WRITE(6,1770)
      NUMBER=2+NPRØB+3
 1745 KK=KK+4
      KKK=KK+3
      WRITE(6,1739)
 1739 FØRMAT(1H )
      DØ 1764 L=1,NPRØB
      WRITE(6,1765) J,L,(DRE(K,L),K=KK,KKK)
 1765 FØRMAT(15X,I2,18X,I2,9X,4(3X,E14.7,3X))
 1764 CØNTINUE
 1735 CØNTINUE
      DØ 71  NR=1,NREG
      DØ 71  K=1,2
      II =(JRTIC(NR) - 1) *4 +1
      IF(K.EQ.2) II= JRSTØP(NR)*4-3
      III= II + 3
      DØ 71 I = II,III
   71 WRITE(3) (DRE(I,J),J=1,NPRØB)
      REWIND 2
      REWIND 3
      REWIND 4
      GØTØ 7
 8777 IERRØR =8777
      NERRØR=32
      NIX=1
    7 CØNTINUE
      RETURN
      END
```

```
C ..... RØUTINE **D15     ** ABACUS UPDATED 07/19/72 .....
      SUBRØUTINE FLEX (A,M,LØC,MID,NIX)
C
C   MATRIX INVERSIØN
C
C  A-CØNVENTIØNAL FØRTRAN DØUBLE ARRAY CØNTAINING MATRIX TØ BE INVERTED
C  M- MATRIX ØRDER
C  LØC-  SINGLE ARRAY DIMENSIØNED AT LEAST TØ M
C  MID-  FIRST DIMENSIØN ØF A,NØT LESS THAN M
C  NIX-  ERRØR INDICATØR, SET TØ ZERØ AFTER SUCCESSFUL EXECUTIØN.
C
      DIMENSIØN A(MID,1)
      INTEGER LØC(1)
  100 N = M
      DØ 190  K = 1,N
      PIVØT =-0.0
      DØ 120  I = K,N
      IF (PIVØT -  ABS(A(I,K))) 110,110,120
  110 PIVØT =  ABS(A(I,K))
      L = I
  120 CØNTINUE
      IF (PIVØT) 140,130,140
  130 NIX = -1
      GØ TØ 210
  140 LØC(K) = L
      DØ 150  J = 1,N
      TEMP1 = A(K,J)
      A(K,J) = A(L,J)
  150 A(L,J) = TEMP1
      TEMP1=A(K,K)
      A(K,K) = 1.0
      DØ 160  J = 1,N
  160 A(K,J) = A(K,J)/TEMP1
      DØ 190  I = 1,N
      IF (I - K) 170,190,170
  170 TEMP1 = -A(I,K)
      A(I,K) = 0.0
      DØ 180   J = 1,N
  180 A(I,J) = A(I,J) + TEMP1*A(K,J)
  190 CØNTINUE
      DØ 200  K = 1,N
      NK = N - K
      L = LØC(NK+1)
      DØ 200  I = 1,N
      TEMP1 = A(I,NK+1)
      A(I,NK+1) = A(I,L)
  200 A(I,L) = TEMP1
      NIX = 0
  210 RETURN
      END
```

SUBROUTINE INITAL

As a result of the matrix operations performed in REGMAT, the SKL22, the XK2221, and the XK22L2 arrays for each region are passed to INITAL. The XK1112 and XL1 arrays for each segment, resulting from the matrix procedures in SEGMAT, are also passed to INITAL. The region end deflection matrices, DRE, which were formed in STRMAT or BCVECT are transmitted to INITAL.

Following appropriate matrix operations upon these arrays, the force initial conditions, the FICS array, and the deflections initial conditions, the DICS array, are produced. These arrays combine to form the YICS matrix, which contains the true initial conditions for the structure to be analyzed.

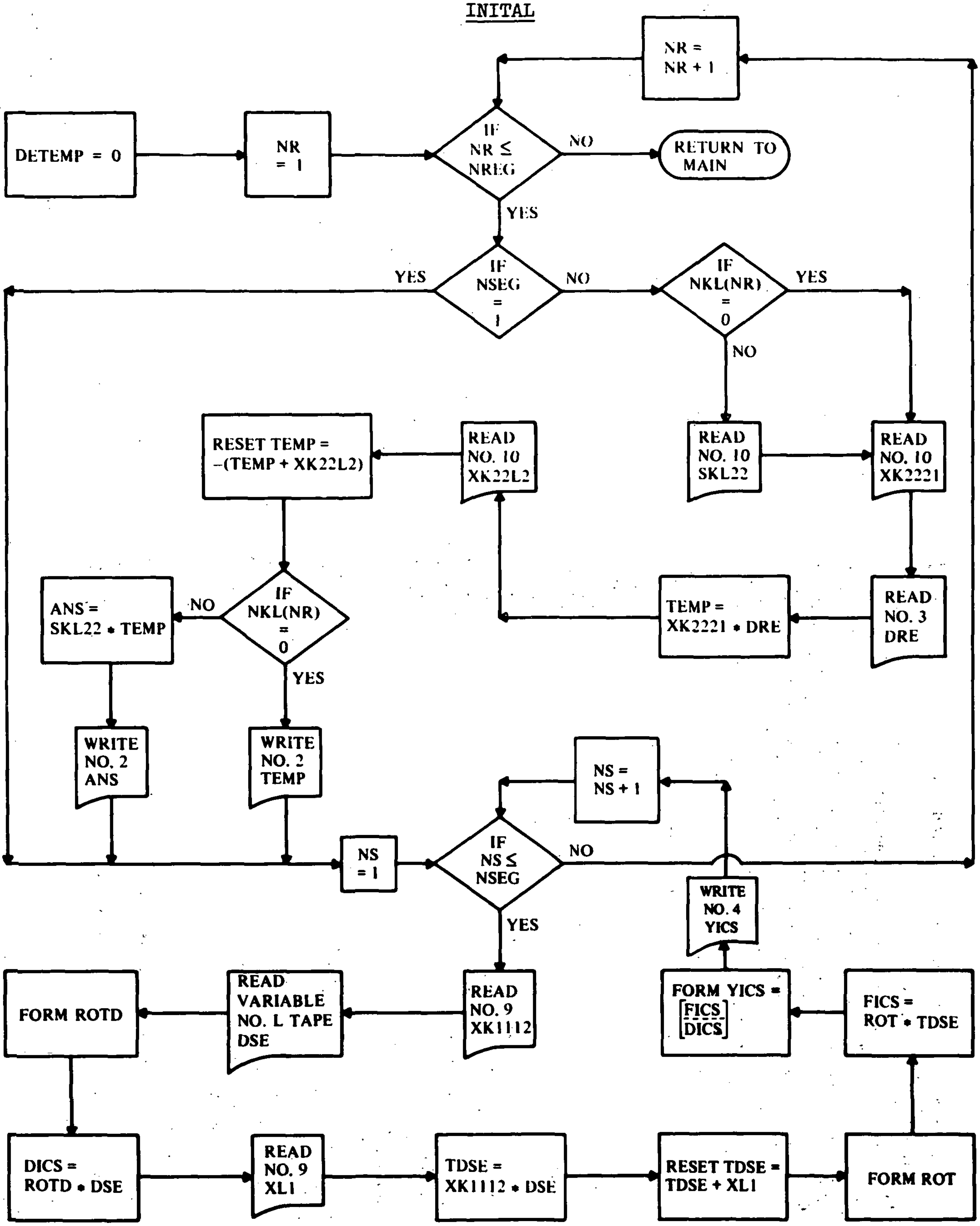
The pertinent counters in the subroutine are:

NS = segment counter

NR = region counter

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1)
XK2221 MATRIX	$\left[\hat{K}_{22}\right]^{-1} \left[\hat{K}_{21}\right]$
XK22L2 MATRIX	$\left[\hat{K}_{22}\right]^{-1} \left[\hat{L}\right]$
DSE ARRAY	$\left\{\Delta\right\}$
XK1112 MATRIX	$\left[k_{ii} \;\vdots\; k_{ij}\right]$
ROTD MATRIX	$\left[IDT\right]^{T}$
DICS ARRAY	$\left\{\delta(i)\right\}$
XL1 ARRAY	$\left\{\ell(i)\right\}$
ROT MATRIX	$\left[IFT\right]^{T}$
FICS ARRAY	$\left\{f(i)\right\}$

INITAL


NR = NR + 1
DETEMP = 0
NR = 1
IF NR ≤ NREG
NO
RETURN TO MAIN
YES
IF NSEG = 1
YES
NO
IF NKL(NR) = 0
YES
NO
RESET TEMP = −(TEMP + XK22L2)
READ NO. 10 XK22L2
READ NO. 10 SKL22
READ NO. 10 XK2221
ANS = SKL22 * TEMP
NO
IF NKL(NR) = 0
YES
TEMP = XK2221 * DRE
READ NO. 3 DRE
WRITE NO. 2 ANS
WRITE NO. 2 TEMP
NS = NS + 1
NS = 1
IF NS ≤ NSEG
NO
YES
WRITE NO. 4 YICS
FORM ROTD
READ VARIABLE NO. L TAPE DSE
READ NO. 9 XK1112
FORM YICS = [FICS DICS]
FICS = ROT * TDSE
DICS = ROTD * DSE
READ NO. 9 XL1
TDSE = XK1112 * DSE
RESET TDSE = TDSE + XL1
FORM ROT

```
C ..... RØUTINE **D16      ** ABACUS UPDATED 07/24/72 .....          1700000
      SUBRØUTINE INITAL                                                 1700010
      INTEGER SAVJTC,SAVSTP,Q,THICK
      INTEGER XN1,XN                                                    1700030
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)         1700040
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)                            1700050
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(2),NH           1700060
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)  1700070
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB 1700080
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE 1700090
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS            1700100
      DIMENSIØN XK2221(112,8),DRE(8,2),TEMP(112,2),XK22L2(112,2)        1700110
      DIMENSIØN XK1112(4,8),DSE(8,2),RØTD(4,4),DICS(4,2)                1700120
      DIMENSIØN TDSE(8,2),YICS(8,2)                                     1700130
      DIMENSIØN XL1(4,2),RØT(4,4),FICS(4,2),SKL22(112,112),ANS(112,2)   1700140
      EQUIVALENCE (RØT(1),RØTD(1)),(TIC,TICK)                           1700150
      EQUIVALENCE (DSE(1),DRE(1)),(XK2221(1),XK22L2(1))                 1700160
      EQUIVALENCE (SKL22(1),XK1112(1)),(YICS(1),TDSE(1))                1700170
      NH4 = 4                                                           1700190
      NH41=NH4+1                                                        1700200
      NH8 = 8                                                           1700210
      NH81=NH8+1                                                        1700220
      REWIND  2                                                         1700230
      REWIND  3                                                         1700240
      REWIND  4                                                         1700250
       REWIND  8                                                        1700260
      REWIND  9                                                         1700270
      REWIND 10                                                         1700280
    1 FØRMAT(1H ,8(E14.7,2X)/(3X,8(E14.7,2X)))                          1700290
      DØ 100 NR=1,NREG                                                  1700300
      NØJ = NST(NR) + NKL(NR) + 1                                       1700310
      ISKL22 = 4*(NØJ-2)                                                1700320
      JSKL22 = 4*(NØJ-2-NKL(NR))                                        1700330
      NJTNH4=NØJ*NH4                                                    1700340
      M8=4*(NØJ-NKL(NR))-8                                              1700350
      NSEG=NST(NR)                                                      1700360
      IF (NSEG.EQ.1) GØTØ 703                                           1700380
      IF(NKL(NR).EQ.0) GØ TØ 415                                        1700390
      DØ 425 I=1,ISKL22                                                 1700400
  425 READ (10) (SKL22(I,J),J=1,JSKL22)                                 1700410
  415 READ(10)  ((XK2221(I,J),J=1,NH8),I=1,M8)                          1700420
      READ(10) (SAVJTC(I),SAVSTP(I),I=1,NSEG)                           1700430
  703 DØ 91 K = 1,2                                                     1700440
      II = 1                                                            1700450
      IF(K.EQ.2) II=5                                                   1700460
      III = II+3                                                        1700470
      DØ 91 I=II,III                                                    1700480
   91 READ(3) (DRE(I,J),J=1,NPRØB)                                      1700490
      IF (NSEG.EQ.1) GØTØ 999                                           1700500
      DØ 101 J=1,NPRØB                                                  1700510
      DØ 101 I=1,M8                                                     1700520
      TEMP(I,J)=0.0                                                     1700530
      DØ 101 K=1,NH8                                                    1700540
      TEMP(I,J)=TEMP(I,J)+XK2221(I,K)*DRE(K,J)                          1700550
  101 CØNTINUE                                                          1700560
      IF (NH.NE.0) GØ TØ 510                                            1700570
      READ(10)((XK22L2(I,J),J=1,NPRØB),I=1,M8)                          1700580
      GØ TØ 511                                                         1700590
  510 DØ 512 I=1,M8                                                     1700600
```

```
      DØ 512 J=1,NPRØB
  512 XK22L2(I,J)=0.0
  511 CØNTINUE
      DØ 102 J=1,NPRØB
      DØ 102 I=1,M8
  102 TEMP(I,J)= -(TEMP(I,J)+XK22L2(I,J))
      IF(NKL(NR).EQ.0) GØ TØ 435
      DØ 445 I = 1,ISKL22
      DØ 445 J=1,NPRØB
      ANS(I,J)=0.0
      DØ 445 K = 1,JSKL22
  445 ANS(I,J)=ANS(I,J)+SKL22(I,K)*TEMP(K,J)
  435 DØ 391 N=1,NSEG
      IF((N.EQ.1.ØR.N.EQ.NSEG).AND.SAVJTC(N).GT.SAVSTP(N)) GØ TØ 370
      DØ 398 K=1,2
      IF (N.NE.1.ØR.K.NE.1) GØTØ 393
      DØ 394 I= 1,4
  394 WRITE (2) (DRE(I,J),J=1,NPRØB)
      GØ TØ 398
  393 IF(N.EQ.NSEG.AND.K.EQ.2) GØTØ 395
      IF (K.EQ.1) II = SAVJTC(N)*4-7
      IF (K.EQ.2) II = SAVSTP(N)*4-7
      III = II + 3
      DØ 397 I=II,III
      IF (NKL(NR).EQ.0) GØTØ 392
      WRITE (2) (ANS(I,J),J=1,NPRØB)
      GØTØ 397
  392 WRITE (2) (TEMP(I,J),J=1,NPRØB)
  397 CØNTINUE
      GØ TØ 398
  395 DØ 396 I=5,8
  396 WRITE (2)  (DRE(I,J),J=1,NPRØB)
  398 CØNTINUE
      GØ TØ 391
  370 IF(N.EQ.NSEG) GØ TØ 380
      IF(NKL(NR).EQ.0) GØ TØ 375
      DØ 371 I=1,4
  371 WRITE(2) (ANS(I,J),J=1,NPRØB)
      GØ TØ 376
  375 DØ 372 I=1,4
  372 WRITE(2) (TEMP(I,J),J=1,NPRØB)
  376 DØ 373 I=1,4
  373 WRITE(2) (DRE(I,J),J=1,NPRØB)
       GØ TØ 391
  380 II =M8 - 3
       III = M8
       DØ 381 I=5,8
  381 WRITE(2) (DRE(I,J),J=1,NPRØB)
       IF(NKL(NR).EQ.0) GØ TØ 385
       DØ 382 I=II,III
  382 WRITE(2) (ANS(I,J),J=1,NPRØB)
       GØ TØ 391
  385 DØ 383 I=II,III
  383 WRITE(2) (TEMP(I,J),J=1,NPRØB)
  391 CØNTINUE
      REWIND 2
  999 DØ 201 NS=1,NSEG
      READ  (9) ((XK1112(I,J),J=1,NH8),I=1,NH4),IGEØM,G1
      ISEG=0
      NR1=NR-1
      IF(NR1.EQ.0)GØTØ8
```

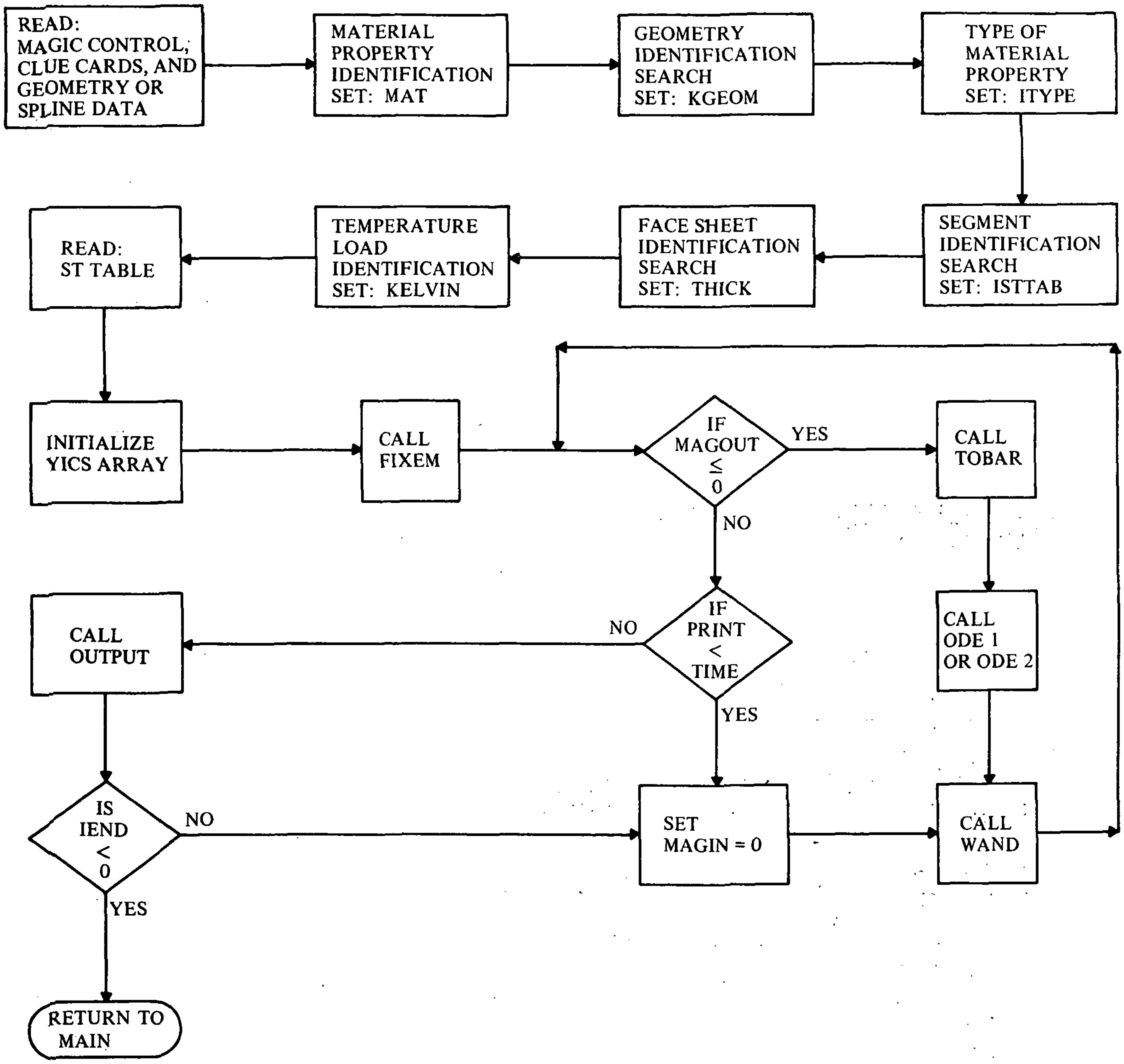
```
      DØ 7 I=1,NR1
    7 ISEG=ISEG+NST(I)
    8 ISEG=ISEG+NS
      TIC= SAVTIC(ISEG)
      GØ TØ (21,22,23),IGEØM
   21 SN = DSIN(TIC)
      CS = DCØS(TIC)
      GØ TØ 25
   22 SN = CØS(1.570796-G1)
      CS = SIN(1.570796-G1)
      GØ TØ 25
   23 SN = 1.0
      CS = 0.0
   25 CØNTINUE
      IF (NSEG.EQ.1) GØ TØ 80
      DØ 78 I = 1,8
   78 READ (2) (DSE(I,J),J=1,NPRØB)
   80 CØNTINUE
      DØ 302 J=1,NH4
      DØ 302 I=1,NH4
  302 RØTD(I,J)=0.0
      DØ 305 J=1,NH4,4
      RØTD(J,J)=1.0
      RØTD(J+1,J+2)=CS
      RØTD(J+2,J+1)=-CS
      RØTD(J+1,J+1)=-SN
      RØTD(J+2,J+2)=-SN
  305 RØTD(J+3,J+3)=1.0
      DØ 306 J=1,NPRØB
      DØ 306 I=1,NH4
      DICS(I,J)=0.0
      DØ 306 K=1,NH4
  306 DICS(I,J)=DICS(I,J)+RØTD(I,K)*DSE(K,J)
      DØ 350 J=1,NPRØB
      DØ 350 I=1,NH4
  350 XL1(I,J) = 0.0
      IF (NH.EQ.0) READ(9) ((XL1(I,J),J=1,NPRØB),I=1,NH4)
      DØ 202 J=1,NPRØB
      DØ 202 I=1,NH4
      TDSE(I,J)=0.0
      DØ 202 K=1,NH8
  202 TDSE(I,J)=TDSE(I,J)+XK1112(I,K)*DSE(K,J)
      DØ 203 J=1,NPRØB
      DØ 203 I=1,NH4
  203 TDSE(I,J)=TDSE(I,J)+XL1(I,J)
      DØ 301 J=1,NH4
      DØ 301 I=1,NH4
  301 RØTD(I,J)=0.0
      DØ 204 J=1,NH4,4
      RØT(J,J)=-1.0
      RØT(J+1,J+2)=-CS
      RØT(J+2,J+1)= CS
      RØT(J+1,J+1)=SN
      RØT(J+2,J+2)=SN
  204 RØT(J+3,J+3)=1.0
      DØ 205 J=1,NPRØB
      DØ 205 I=1,NH4
      FICS(I,J)=0.0
      DØ 205 K=1,NH4
  205 FICS(I,J)=RØT(I,K)*TDSE(K,J)+FICS(I,J)
      DØ 402 J=1,NPRØB
```

```
      DØ 402 I=1,NH4
      II=I+NH4
      YICS(I,J)=FICS(I,J)
  402 YICS(II,J)=DICS(I,J)
      WRITE(4)    ((YICS(I,J),I=1,8),J=1,NPRØB)
  201 CØNTINUE
      REWIND 2
  100 CØNTINUE
      REWIND  1
      REWIND  4
       REWIND  8
      RETURN
       END
```

SUBROUTINE LEBEGE

The subroutine link LEBEGE receives the YICS array for each segment from INITAL via Tape #4. The subroutine FIXEM is called to integrate the differential equations of each segment, under true load conditions. FIXEM is identical to subroutine SETUP, while WAND corresponds to subroutine MAGIC and only consideration of the OVERLAY structure dictates the change in names. The subroutines TOBAR, TEMOEG, PLYCO, and PLYNE are similarly equivalent to ROBOT, GEOMET, PLICO, and PLINE discussed previously.

The results of the final integration sequence are the forces and deflections at the beginning, intermediate, and end points of each segment. In the first pass, first cycle, the prestress and predeformation states are printed from this routine. In other passes the U, V, W eigenvectors are printed, providing convergence has been reached.


READ:
MAGIC CONTROL, CLUE CARDS, AND GEOMETRY OR SPLINE DATA
MATERIAL PROPERTY IDENTIFICATION
SET: MAT
GEOMETRY IDENTIFICATION SEARCH
SET: KGEOM
TYPE OF MATERIAL PROPERTY
SET: ITYPE
SEGMENT IDENTIFICATION SEARCH
SET: ISTTAB
FACE SHEET IDENTIFICATION SEARCH
SET: THICK
TEMPERATURE LOAD IDENTIFICATION
SET: KELVIN
READ:
ST TABLE
INITIALIZE YICS ARRAY
CALL FIXEM
IF MAGOUT ≤ 0
YES
NO
CALL TOBAR
CALL ODE 1 OR ODE 2
IF PRINT < TIME
NO
YES
CALL OUTPUT
SET MAGIN = 0
CALL WAND
IS IEND < 0
NO
YES
RETURN TO MAIN

```
C ..... RØUTINE **D17     ** ABACUS UPDATED 07/24/72 .....
      SUBRØUTINE LEBEGE
      INTEGER SAVJTC,SAVSTP,SEGTAB, Q ,THICK,TYPE
      INTEGER XN
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK
      DØUBLE PRECISIØN DTAU,DIFF,STEP,DELTA,TIME,DTIME
      DØUBLE  PRECISIØN  YNEW,YPRED
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(2),NH
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XNI,KBC,NRINGS
      CØMMØN /NAM1/ FACE(4),STRGØ(7),THERM(4),MATER(3),SEGTAB(12)
      CØMMØN /ARING/ NRING(28)
      CØMMØN /SNILPS/ ANG,PSI(100),RAD(100),CUR1(100),CUR2(100),
     1       DR1DP(100),ZI(14),RI(14),NRZIN
      CØMMØN /MAGIQ/ KKNT
      CØMMØN /LASTEQ/ YPRED(16),YDØT(16),YASAVE(16),
     1               YANTH,YAMTH,YAMPT,YANPT,YAØPH,YAQPH,YAQTH,YAJPH,
     2               S,SN,CS,SNSQ,CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,
     3               X1RØ,X1RØSQ,X1SNRØ,X1CSRØ,CN1RØ,SN1RØ,CS1RØ,
     4               X1R1,X1R2,CS1R1,CS1R2,SN1R1,X1R1SQ,R2SQ,RØ,BESQ,
     5    RØSQ,XNSQ,BETA,R1,R2,S1,R1DØT,R1SQ,
     6               XNTTH,XNTPH,XMTTH,XMTPH,XFTHLD,XFPHLD,XFZELD,
     7  XMTHLD,XMPHLD,ETHET(2),EPHI(2),XGPT(2),ALPHTH(2),ALPHPH(2),
     8               XNUTP,XNUPT,XC11,XC22,XC15,XD33,XD22,XD21,XD12,
     9               XK11,XK12,XK21,XK22,XK33,XD11,
     A                  M,I,SITIN,SITØUT,SIPIN,SIPØUT,TPTIN,TPTØUT,
     B            ZBRIN,ZBRØUT,SCRIPA,SCRIPI,SIFIN,SIFØUT,TZEPH,TZETH
     C               ,XNPHI,BETTA,ZETTA,SAVY(8),XC16
      DIMENSIØN TMPAV(5),RWØ(8)
      DIMENSIØN LST(13),YDEV(16),YICS(16),YNEW(16)
      DIMENSIØN XKF(128),TBDEL(16),FWDEL(16),YCØRR(16)
      DIMENSIØN ST(72,31), XLAYER(10)
      DIMENSIØN XSAVY(3,2)
      EQUIVALENCE (XMTTH,XMTETH),(XMTPH,XMTEPH),(XNTTH,XNTETH),
     1            (XNTPH,XNTEPH)
      EQUIVALENCE  (XNPHI,XNPI)
      EQUIVALENCE (YNEW(1),XKF(1))
      EQUIVALENCE (XSAVY(1,1),SAVY(1))
      REWIND  1
  600 FØRMAT(1H ,8(E14.7,2X)/(3X,8(E14.7,2X)))
      KSC = 0
      JAM =1
      JNSC =0
      DØ 451 I=1,NREG
  451 KSC = KSC + NST(I)
      LSC = 0
  902 LSC = LSC + 1
      XNTTH = 0.0
      XNTPH = 0.0
      XMTTH = 0.0
      XMTPH = 0.0
      NSC=LSC
      JNSC=JNSC+1
      IF(JNSC.LE.NST(JAM)) GØ TØ 1727
      NRNG = NRING(JAM)
      IF (NRNG.EQ.0) GØ TØ 1900
```

```
      DØ 1901 I=1,NRNG
 1901 READ(1) DUMLNK
 1900 CØNTINUE
      NNSKL = NKL(JAM)
      IF (NNSKL.EQ.0) GØ TØ 1724
      DØ 1725 I=1,NNSKL
 1725 READ(1) DUMLNK
 1724 CØNTINUE
      JAM=JAM+1
      JNSC=1
 1727 CØNTINUE
      READ(1) RGØ,ANG,STØRY
      READ(1) DTAU,DIFF,STEP,DELTA
      IF (RGØ.EQ.14.0) GØ TØ 182
      READ(1)       G1,G2,G3
      GØ TØ 183
  182 READ(1) NRZIN,(ZI(J),RI(J),J=1,NRZIN)
  183 CØNTINUE
      READ(1) TYPE,HLAYR,SHEET,INTERP,RANKIN,TEFREE,NP
      DIFF  =1.0E-04
      EPSIL =1.0E-05
      ERR = 1.0 E-07
      I = RGØ
      WRITE(6,1726)
 1726 FØRMAT(1H1)
      IF(JNSC.EQ.1) WRITE(6,606) JAM,NST(JAM),NKL(JAM)
  606 FØRMAT(//58X,13HREGIØN NUMBER,I3//35X,10HTHERE ARE ,I2,14H SEGMENT
     1S AND ,I2,35H KINEMATIC LINKS WITHIN THIS REGIØN)
      WRITE(6,651)  JNSC,I  ,(STØRY(I),I=1,16)
  651 FØRMAT(//13X,15HSEGMENT NUMBER ,I2,5X,13HSEGMENT CØDE ,I2,5X,
     116A4)
C     MATERIAL PRØPERTY IDENTIFICATIØN
      DØ 501 I=1,NMPT
      IF (HLAYR-STD(I)) 501,502,501
  502 MAT=I
      GØTØ 503
  501 CØNTINUE
      GØTØ 8036
  503 CØNTINUE
C     GEØMETRY IDENTIFICATIØN SEARCH
      DØ 504 I=1,7
      IF(RGØ-STRGØ(I)) 504,505,504
  504 CØNTINUE
      GØTØ 8086
  505 KGEØM=I
      IGEØM = 0
      IF (KGEØM.EQ.1.ØR.KGEØM.EQ.2.ØR.KGEØM.EQ.5.ØR.KGEØM.EQ.6) IGEØM =1
      IF (KGEØM.EQ.3) IGEØM=2
      IF(KGEØM.EQ.4) IGEØM=3
      IF ( KGEØM.EQ.7 ) IGEØM = 1
      DØ 506 I=1,3
      IF(TYPE-MATER(I))506,507,506
  506 CØNTINUE
      GØTØ 8087
  507 ITYPE=I
      DØ 510 I=1,12
      IF(INTERP-SEGTAB(I))510,511,510
  510 CØNTINUE
      GØ TØ 8088
  511 ISTTAB=I
      DØ 508 I=1,4
```

```
      IF (SHEET.EQ.FACE(I)) GØTØ 509                                      1801240
  508 CØNTINUE                                                            1801250
      GØTØ 8089                                                           1801260
  509 THICK=I                                                             1801270
C     TEMPERATURE LØAD IDENTIFICATIØN                                     1801280
      DØ 401 I=1,4                                                        1801290
      IF(RANKIN.EQ.THERM(I))GØTØ 402                                      1801300
  401 CØNTINUE                                                            1801310
      GØTØ 8090                                                           1801320
  402 KELVIN=I                                                            1801330
      KLUE2=1                                                             1801340
      GØ TØ (430,430,420,420,420,420,425,425,425, 430,430,430),ISTTAB     1801350
  420 KLUE2=2                                                             1801360
      GØ TØ 430                                                           1801370
  425 KLUE2=3                                                             1801380
  430 KLUE1=THICK                                                         1801390
C                                                                         1801400
C     LINEAR ANALYSIS IDENTIFICATIØN                                      1801410
      IANLYZ = 1                                                          1801420
      NRØW = THICK + 1                                                    1801430
      IF (ISTTAB.EQ.1) NRØW = 11                                          1801440
      IF (ISTTAB.EQ.3) NRØW = 12                                          1801450
      IF (ISTTAB.EQ.4) NRØW = 8                                           1801460
      IF (ISTTAB.EQ.5) NRØW = 9                                           1801470
      IF (ISTTAB.EQ.6) NRØW = 10                                          1801480
      IF (ISTTAB.EQ.7) NRØW = 7                                           1801490
      IF (ISTTAB.EQ.8) NRØW = 8                                           1801500
      IF (ISTTAB.EQ.9) NRØW = 9                                           1801510
      IF (ISTTAB.EQ.10) NRØW = 12                                         1801520
      IF (ISTTAB.EQ.11) NRØW = 13                                         1801530
      IF (ISTTAB.EQ.12) NRØW = 14                                         1801540
      IF (KBC.NE.0) NRØW = NRØW+2*NLCASE                                  1801550
       DØ 901  I=1,NRØW                                                   1801560
      READ(1)          (ST(I,J),J=1,NP)                                   1801570
  901 CØNTINUE                                                            1801580
      DØ 750 JJ=1,12                                                      1801590
  750 LST(JJ) = 0                                                         1801600
      IF (KBC.NE.0) GØ TØ 590                                             1801610
      K=NRØW+1                                                            1801620
      JJ=1                                                                1801630
      JJJ=6                                                               1801640
      MM=1                                                                1801650
      NRW = NRØW                                                          1801711
      DØ 17 NLC=1,NLCASE                                                  1801660
      JT = JJ                                                             1801670
      JTT= JJJ                                                            1801680
      L=0                                                                 1801690
      READ(1) (LST(J),J=JJ,JJJ)                                           1801700
      IF(LST(JJ))8031,19,20                                               1801710
   20 L = LST(JJ)                                                         1801720
      IF (NLC.GT.1.AND.LST(1).NE.0.AND.LST(JT).NE.0) GØ TØ 8008           1801730
   19 JJ=JJ+1                                                             1801740
   23 IF(LST(JJ))8031,22,21                                               1801750
   21 L=L+1                                                               1801760
   22 IF(JJ.EQ.JJJ) GØTØ 24                                               1801770
      JJ=JJ+1                                                             1801780
      GØTØ 23                                                             1801790
   24 IF(L.EQ.0) GØ TØ 71                                                 1801800
      KK = K + L - 1                                                      1801810
      DØ 72 M=K,KK                                                        1801820
      READ(1)          (ST(M,J),J=1,NP)                                   1801830
```

```
   72 CØNTINUE                                                              1801840
      IF (LST(JT).EQ.0) GØ TØ 660                                           1801850
      KZ = K + LST(1) -1                                                    1801860
      K = KZ + 1                                                            1801870
  660 CØNTINUE                                                              1801880
   71 K = K + L - LST(JT)                                                   1801890
      IF (NLC.EQ.1.AND.LST(1).EQ.0) NRW = K-1                               1801951
      JJ=JJJ+1                                                              1801900
      JJJ=JJ+5                                                              1801910
   17 MM=MM+1                                                               1801920
  590 CØNTINUE                                                              1801930
      READ(1) IS,SAVJTC(IS),SAVSTP(IS),STØRY                                1801940
      NSAVE = NRØW                                                          1801950
      JJ=NLCASE*6
      LT=0                                                                  1801970
      DØ 15  J=1,JJ                                                         1801980
   15 LT=LT+LST(J)                                                          1801990
      NTØTAL=LT+NSAVE                                                       1802000
      NEQNS=8*NPRØB                                                         1802010
      TIC = ST(1,1)                                                         1802020
      STØP = ST(1,NP)                                                       1802030
      READ(4)     (YICS(I),I=1,NEQNS)                                       1802040
      NCYC=0                                                                1802050
      NSAVE=NRØW                                                            1802060
      IEND=0                                                                1802070
      PRINT=TIC                                                             1802080
      DTA=DTAU                                                              1802090
      DTAU=0.0                                                              1802100
      IF (NH.EQ.0) WRITE(6,656)                                             1802110
  656 FØRMAT(//5X,-PHI  ØR  S-,13X,-NTHETA-,11X,-NPHI-,11X,-ØMEGATH-)       1802120
      IF (NH.EQ.0.AND.NLCASE.EQ.2) WRITE(6,657)                             1802130
  657 FØRMAT(1H+,80X,-NTHETA-,11X,-NPHI-,11X,-ØMEGATH-)                     1802140
      IF (NH.NE.0) WRITE(6,671)                                             1802150
  671 FØRMAT(//27X,-V E C T Ø R     1-,37X,-V E C T Ø R     2-
     1//3X,-PHI  ØR  S-,10X,-U-,14X,-V-,14X,-W-,9X,-ØMEGA THETA-,8X,
     2-U-,14X,-V-,14X,-W-,9X,-ØMEGA THETA-/)
      IF (NH.EQ.0) WRITE(6,661)                                             1802170
  661 FØRMAT(1X)                                                            1802180
      IF (NH.NE.0.AND.KBC.EQ.0) READ(13) SAVY                               1802231
   59 CALL FIXEM (MAGIN,MAGØUT,TIC,STEP,NEQNS,DTAU,EPSIL,DELTA,ERR,TIME,    1802210
     1            DTIME,YICS,YPRED,YCØRR,YDØT,YNEW,YDEV,FWDEL,TBDEL)        1802220
      GØTØ  61                                                              1802230
   60 CALL WAND(MAGIN,MAGØUT,TIC,STEP,NEQNS,DTAU,EPSIL,DELTA,ERR,TIME,      1802240
     1           DTIME,YICS,YPRED,YCØRR,YDØT,YNEW,YDEV,FWDEL,TBDEL)         1802250
   61 IF(MAGØUT.LE.0) GØTØ 25                                               1802280
      IF (NH.EQ.0.AND.KBC.EQ.0) WRITE(13) SAVY                              1802290
      IF(TIME.GT.STØP) GØTØ 62                                              1802300
      IF(TIME.LT.STØP) GØTØ 63                                              1802310
   64 IEND=-1                                                               1802320
      GØTØ 67                                                               1802330
   62 IF(TIME.LE.(STØP+DIFF)) GØTØ 64                                       1802340
      GØTØ 8001                                                             1802350
   63 IF((STØP-DIFF).LE.TIME) GØTØ 64                                       1802360
      IF((TIME+DTIME).GT.STØP) GØTØ 65                                      1802370
      IF(PRINT.GT.TIME) GØTØ 66                                             1802380
      PRINT=TIME+DTA                                                        1802390
   67 IF (NH.EQ.0) WRITE(6,1333)TIME,((XSAVY(J1,K1),J1=1,3),K1=1,NLCASE)   1802400
 1333 FØRMAT(1X,1PE16.7,2(5X,1P3E16.7))                                     1802410
      IF (NH.NE.0) WRITE(6,1334) TIME,RWØ                                   1802470
 1334 FØRMAT(1X,1PE13.7,2(1X,1P3E15.7,1PE13.5))
 6450 IF(IEND.GT.0) GØ TØ 8002                                              1802440
```

```
      IF(IEND.LT.0) GØTØ  150                                           1802450
   66 MAGIN=0                                                           1802460
      GØTØ 60                                                           1802470
   65 DTIME=STØP-TIME                                                   1802480
      DELTA=0.0                                                         1802490
      GØTØ 67                                                           1802500
   75 NCYC=NCYC+1                                                       1802510
      MAGIN=-1                                                          1802520
      GØTØ 60                                                           1802540
   25 PHI=TIME                                                          1802550
      ARG=PHI                                                           1802560
      IF (NH.NE.0.AND.KKNT.EQ.4.AND.KBC.EQ.0) READ(13) SAVY             1802611
      LL=NP+1                                                           1802570
      DØ 51 I=1,NP                                                      1802580
      IF(ARG-ST(1,I)) 52,55,51                                          1802590
   52 IF(I-1) 55,55,54                                                  1802600
   51 CØNTINUE                                                          1802610
      I=NP                                                              1802620
      GØ TØ 55                                                          1802630
   54 DØ 57 IK=2,NTØTAL                                                 1802640
   57 ST(IK,LL)=ST(IK,I-1)+(ST(IK,I)-ST(IK,I-1))*(ARG-ST(1,I-1))/(ST(1,I 1802650
     1)-ST(1,I-1))                                                      1802660
      GØTØ 80                                                           1802670
   55 DØ 58 IK=2,NTØTAL                                                 1802680
   58 ST(IK,LL)=ST(IK,I)                                                1802690
   80 CØNTINUE                                                          1802700
C     THE UPDATED INTERPØLATED VALUES ØF THE MATERIAL PRØPERTY CØEFFIC  1802710
C     IENTS ARE FØUND IN THE XMAT TABLE AND STØRED IN THE XLAYER ARRAY  1802720
      L=(MAT-1)*2+1                                                     1802730
      II=NXMAT(L)                                                       1802740
       III=NXMAT(L+1)                                                   1802750
      LL=NP+1                                                           1802760
      L=NRØW + 1                                                        1802770
      IF(KELVIN .NE. 1)GØ TØ 81                                         1802780
      IF(THICK.NE.1)GØ TØ 83                                            1802790
   81 LØØP=1                                                            1802800
      ILØW=1                                                            1802810
      IHIGH = 1                                                         1802820
      IF(KELVIN .NE. 1)GØ TØ 85                                         1802830
   82 CØNTINUE                                                          1802840
      TMPAV(ILØW)=(ST(L,LL)+ ST(L+1,LL)+ ST(L+2,LL) + ST(L+3,LL))/4.0   1802850
      GØ TØ 85                                                          1802860
   83 LØØP = 2                                                          1802870
      ILØW= 1                                                           1802880
      IHIGH = 2                                                         1802890
      TMPAV(ILØW)= (ST(L,LL)+ ST(L+1,LL))/2.0                           1802900
      TMPAV(IHIGH)=(ST(L+2,LL) + ST(L+3,LL))/2.0                        1802910
   85 DØ 105 IL=ILØW,IHIGH                                              1802920
      M=1                                                               1802930
      GØTØ (91,92,93,93),KELVIN                                         1802940
   91 ARG= TMPAV(IL)                                                    1802950
      GØTØ 94                                                           1802960
   93 CØNTINUE                                                          1802970
      ARG = ST(NRØW+1,LL)                                               1802980
      TMPAV(1) = ARG                                                    1802990
   94 DØ 104 I = 2,10                                                   1803000
      IF (ARG-XMAT(II,I)) 121,123,104                                   1803010
  121 IF (I-2) 8007,8007,124                                            1803020
  104 CØNTINUE                                                          1803030
      GØTØ 8067                                                         1803040
  123 L=II+1                                                            1803050
```

```
      DØ 122 J=L,III
      XLAYER(M)=XMAT(J,I)
  122 M=M+1
      GØTØ 111
  124 L=II+1
      DØ 125 J=L,III
      XLAYER(M)=XMAT(J,I-1)+(XMAT(J,I)-XMAT(J,I-1))*(ARG-XMAT(II,I-1))/
     1          (XMAT(II,I)-XMAT(II,I-1))
  125 M=M+1
      GØTØ 111
   92 L = II + 1
      DØ 922  J=L,III
      XLAYER(M)= XMAT(J,1)
  922 M=M+1
  111 GØ TØ (115,115,112,113,114),LØØP
  112 XNUTP= XLAYER(2)
      IF(ITYPE.NE. 1)GØ TØ 131
      XNUPT= XNUTP
      XGPT(1) = ETHET(1)/(2*(1+ XNUPT) )
      XGPT(2) = ETHET(2)/(2*(1+ XNUPT) )
      GØ TØ 106
  131 XNUTP = XLAYER(3)
      XNUPT = ETHET(1)*XNUTP/EPHI(1)
      GØ TØ 106
  113 ES= XLAYER(8)
      ALPHS=XLAYER(10)
      GØ TØ 106
  114 ALPHR = XLAYER(9)
      ER = XLAYER(7)
      GØ TØ 118
  115 GØ TØ(101,102,103),ITYPE
  101 ETHET(IL)= XLAYER(1)
      XNUTP     =XLAYER(2)
      ALPHTH(IL)= XLAYER(3)
      EPHI(IL) = ETHET(IL)
      XNUPT= XNUTP
      ALPHPH(IL)= ALPHTH(IL)
      XGPT(IL)= ETHET(IL)/(2.0*(1.0+ XNUPT))
      GØ TØ 105
  102 ETHET(IL)= XLAYER(1)
      EPHI(IL) = XLAYER(2)
      XNUTP = XLAYER(3)
      ALPHTH(IL)= XLAYER(4)
      ALPHPH(IL)= XLAYER(5)
      XGPT(IL) = XLAYER(6)
      XNUPT= ETHET(IL)* XNUTP/EPHI(IL)
      GØ TØ 105
  103 ETHET(IL)= XLAYER(1)
      EPHI(IL)= XLAYER(2)
      XNUTP= XLAYER(3)
      ALPHTH(IL) = XLAYER(4)
      ALPHPH(IL) = XLAYER(5)
      XGPT(IL) = XLAYER(6)
      ER= XLAYER(7)
      ES =XLAYER(8)
      ALPHR = XLAYER(9)
      ALPHS = XLAYER(10)
      XNUPT = ETHET(IL) * XNUTP/EPHI(IL)
  105 CØNTINUE
  106 L = NRØW+1
      GØ TØ (117,107,108,281,118),LØØP
```

```
107 LØØP= 3                                                               1803670
    ILØW = 3                                                              1803680
    IHIGH= 3                                                              1803690
    GØ TØ 82                                                              1803700
108 IF(ITYPE .EQ.3 .AND. ISTTAB .GE. 3)GØ TØ 109                          1803710
    GØ TØ 118                                                             1803720
109 LØØP= 4                                                               1803730
    ILØW =4                                                               1803740
    IHIGH = 4                                                             1803750
    CPH = ST(3,LL)                                                        1803760
    IF(ISTTAB.GE. 10.AND. ISTTAB.LE. 12)CPH = ST(6,LL)                    1803770
    IF(CPH     .LE.0)GØ TØ 284                                            1803780
    TMPAV(4)= ST(L,LL)                                                    1803790
    GØ TØ 85                                                              1803800
284 TMPAV(4) =ST(L+3,LL)                                                  1803810
    GØ TØ 85                                                              1803820
281 LØØP=5                                                                1803830
    ILØW=5                                                                1803840
    IHIGH=5                                                               1803850
    CTH = ST(3,LL)                                                        1803860
    IF(ISTTAB .GE. 10 .AND. ISTTAB .LE. 12)CTH = ST(7,LL)                 1803870
    IF(CTH     .LE. 0)GØ TØ 116                                           1803880
    TMPAV(5)= ST(L,LL)                                                    1803890
    GØ TØ 85                                                              1803900
116 TMPAV(5)= ST(L+3,LL)                                                  1803910
    GØ TØ 85                                                              1803920
117 CØNTINUE                                                              1803930
    ETHET(2)= ETHET(1)                                                    1803940
    ALPHTH(2)=ALPHTH(1)                                                   1803950
    ALPHPH(2)=ALPHPH(1)                                                   1803960
    XGPT(2)= XGPT(1)                                                      1803970
    EPHI(2)= EPHI(1)                                                      1803980
118 CØNTINUE                                                              1803990
    CALL TØBAR (ST,KLUE2,NRØW,NRW,LL,ER,ES,E1,E2,HI,HØ,T,TII,TØØ,TIK,     1804080
   1            TØK,DEGRES,G2,G3,TIME)                                    1804090
    IF (NIX.NE.0) GØ TØ 9999                                              1804020
    LL=NP+1                                                               1804030
    IF(XK11.EQ.0.0) GØTØ 8101                                             1804040
    IF(ITYPE.EQ.3.AND.XK12.EQ.0.) GØ TØ 8102                              1804050
    IF(ITYPE.EQ.3.AND.XK21.EQ.0.) GØ TØ 8103                              1804060
    IF(XK22.EQ.0.0) GØTØ 8104                                             1804070
    IF(XK33.EQ.0.0) GØTØ 8105                                             1804080
    IF(XD11.EQ.0.0) GØTØ 8106                                             1804090
    IF(ITYPE.EQ.3.AND.XD12.EQ.0.) GØ TØ 8107                              1804100
    IF(ITYPE.EQ.3.AND.XD21.EQ.0.) GØ TØ 8108                              1804110
    IF(XD22.EQ.0.0) GØTØ 8109                                             1804120
    IF(XD33.EQ.0.0) GØTØ 8110                                             1804130
    NL=0                                                                  1804140
    NLCSE=NLCASE
    IF(NH.EQ.0) NLCSE=1
    XFPHL1=0.0
    XFZEL1=0.0
    XFPHL2=0.0
    XFZEL2=0.0
    XNPHI = 0.0                                                           1804150
    JF = NPRØB                                                            1804160
    K = NRØW                                                              1804170
    DØ 7 M=1,JF                                                           1804180
    I = (M-1)*8 + 1                                                       1804190
    IF(KBC.NE.0) GØ TØ 255
    IF(NH.EQ.0) GØ TØ 350
```

```
      K=NRØW
      NL=0
  350 DØ 250 JKL=1,NLCSE
      NL=NL+1                                                           1804200
      XFTHLD=0.0                                                        1804210
      XFPHLD=0.0                                                        1804220
      XFZELD=0.0                                                        1804230
      XMTHLD=0.0                                                        1804240
      XMPHLD=0.0                                                        1804250
      IR=NL*6-5                                                         1804270
      IF(LST(IR).NE.0) K=K+LST(IR)                                      1804280
      IF (LST(IR+1).EQ.0) GØTØ 44                                       1804290
      K=K+1                                                             1804300
      XFTHLD=ST(K,LL)                                                   1804310
   44 IF(LST(IR+2).EQ.0) GØTØ 45                                        1804320
      K=K+1                                                             1804330
      XFPHLD=ST(K,LL)                                                   1804340
   45 IF(LST(IR+3).EQ.0) GØTØ 46                                        1804350
      K=K+1                                                             1804360
      XFZELD=ST(K,LL)                                                   1804370
   46 IF(LST(IR+4).EQ.0) GØTØ 47                                        1804380
      K=K+1                                                             1804390
      XMTHLD=ST(K,LL)                                                   1804400
   47 IF(LST(IR+5).EQ.0) GØTØ 48                                        1804410
      K=K+1                                                             1804420
      XMPHLD=ST(K,LL)                                                   1804430
   48 CØNTINUE                                                          1804440
      IF(JKL.EQ.2) GØ TØ 251
      XFPHL1=XFPHLD
      XFZEL1=XFZELD
  251 XFPHL2=XFPHLD
      XFZEL2=XFZELD
  250 CØNTINUE
  255 CØNTINUE
      IF (ISTTAB.GE.3.AND.ISTTAB.LE.9) GØ TØ 4002                       1804450
      CALL ØDE1(XFPHL1,XFZEL1,XFPHL2,XFZEL2)
      GØ TØ 77                                                          1804470
 4002 CALL ØDE2(XFPHL1,XFZEL1,XFPHL2,XFZEL2)
   77 IF (NH.NE.0) GØ TØ 8                                              1804490
      NN = (M-1)*3+1                                                    1804500
      SAVY(NN) = YANTH                                                  1804510
      SAVY(NN+1) = YPRED(I+1)                                           1804520
      SAVY(NN+2) = YPRED(I+7)                                           1804530
      GØ TØ (177,178,179),IGEØM
  177 SAVY(M+6) = X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)
      GØ TØ 7
  178 SAVY(M+6) = (1.0/(S*CS))*(XN*YPRED(I+4)+CS*YPRED(I+5)-SN*
     1            YPRED(I+6))
      GØ TØ 7
  179 SAVY(M+6) = X1RØ*(XN*YPRED(I+4)-YPRED(I+6))
      GØ TØ 7                                                           1804540
    8 N=1
      IF(M.EQ.2) N=5
      RWØ(N)=YPRED(I+4)
      RWØ(N+1)=YPRED(I+5)
      RWØ(N+2)=YPRED(I+6)
      RWØ(N+3)=YPRED(I+7)
    7 CØNTINUE                                                          1804590
      GØTØ 75                                                           1804600
 8001 IERRØR=8001                                                       1804610
      NERRØR = 11                                                       1804620
```

```
      GØTØ 8888                                            1804630
 8002 IERRØR=8002                                          1804640
      NERRØR = 12                                          1804650
      GØTØ 8888                                            1804660
 8007 IERRØR=8007                                          1804670
      NERRØR = 15                                          1804680
      GØTØ 8888                                            1804690
 8008 IERRØR = 8008                                        1804700
      NERRØR = 10                                          1804710
      GØ TØ 8888                                           1804720
 8031 IERRØR=8031                                          1804730
      NERRØR = 9                                           1804740
      GØTØ 8888                                            1804750
 8036 IERRØR=8036                                          1804760
      NERRØR = 2                                           1804770
      GØTØ 8888                                            1804780
 8086 IERRØR=8086                                          1804790
      NERRØR = 3                                           1804800
      GØTØ 8888                                            1804810
 8087 IERRØR=8087                                          1804820
      NERRØR = 4                                           1804830
      GØTØ 8888                                            1804840
 8088 IERRØR=8088                                          1804850
      NERRØR = 27                                          1804860
      GØTØ 8888                                            1804870
 8089 IERRØR=8089                                          1804880
      NERRØR = 5                                           1804890
      GØTØ 8888                                            1804900
 8090 IERRØR=8090                                          1804910
      NERRØR = 6                                           1804920
      GØTØ 8888                                            1804930
 8067 IERRØR= 8067                                         1804940
      NERRØR = 16                                          1804950
      GØTØ 8888                                            1804960
 8101 IERRØR = 8101                                        1804970
      NERRØR = 17                                          1804980
      GØTØ 8888                                            1804990
 8102 IERRØR = 8102                                        1805000
      NERRØR = 18                                          1805010
      GØTØ 8888                                            1805020
 8103 IERRØR = 8103                                        1805030
      NERRØR = 19                                          1805040
      GØTØ 8888                                            1805050
 8104 IERRØR = 8104                                        1805060
      NERRØR = 20                                          1805070
      GØTØ 8888                                            1805080
 8105 IERRØR = 8105                                        1805090
      NERRØR = 21                                          1805100
      GØTØ 8888                                            1805110
 8106 IERRØR = 8106                                        1805120
      NERRØR = 22                                          1805130
      GØTØ 8888                                            1805140
 8107 IERRØR = 8107                                        1805150
      NERRØR = 23                                          1805160
      GØTØ 8888                                            1805170
 8108 IERRØR = 8108                                        1805180
      NERRØR = 24                                          1805190
      GØTØ 8888                                            1805200
 8109 IERRØR = 8109                                        1805210
      NERRØR = 25                                          1805220
      GØTØ 8888                                            1805230
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```
8110 IERRØR = 8110
     NERRØR = 26
8888 NIX=1
     GØ TØ 9999
 150 IF(LSC.LT.KSC) GØ TØ 902
9999 RETURN
     END
```

```
C ..... RØUTINE **D18      ** ABACUS UPDATED 07/07/72 .....                    1900000
      SUBRØUTINE FIXEM (MAGIN,MAGØUT,TIC,STEP,NEQNS,DTAU,
     1                  EPSIL,DELTA,ERR,TIME,DTIME,YICS,YPRED,
     2                  YCØRR,YDØT,YNEW,YDEV,FWDEL,TBDEL)                      1900030
C     RUNGE KUTTA MAGIC (REVISED)  SINGLE PRECISIØN          FØRTRAN IV        1900040
      DIMENSIØN YICS( 1),YPRED( 1),YCØRR( 1), YDØT( 1), YNEW( 1),              1900050
     1          YDEV(1),FWDEL(1),TBDEL(1)
      DIMENSIØN C(3),D(3)                                                      1900080
      CØMMØN /MAGIQ/ KKNT                                                      1900081
      DØUBLE PRECISIØN YNEW,YPRED                                              1900090
      DØUBLE PRECISIØN TIC,STEP,DTAU,DELTA,TIME,DTIME                          1900100
      DATA C,D / .5,.5,1.0,.5,.0,.5/                                           1900110
      MSET=1                                                                   1900120
      TIME = TIC                                                               1900130
      TAU  = TIC                                                               1900140
      IF (DELTA)200,201,200                                                    1900150
  200 DTIME = 0.0078125                                                        1900160
      GØ TØ 225                                                                1900170
  201 DTIME = STEP                                                             1900180
  225 DØ 102 I = 1,NEQNS                                                       1900190
      YDEV(I)  = 0.0                                                           1900200
      YPRED(I) = YICS(I)                                                       1900210
      YCØRR(I) = YICS(I)                                                       1900220
  102 YNEW(I)  = YICS(I)                                                       1900230
      MAGØUT   =-2                                                             1900240
      GØ TØ 264                                                                1900250
 5555 CØNTINUE                                                                 1900260
      ENTRY WAND (MAGIN,MAGØUT,TIC,STEP,NEQNS,DTAU,EPSIL,DELTA,ERR,
     1            TIME,DTIME,YICS,YPRED,YCØRR,YDØT,YNEW,YDEV,FWDEL,
     2            TBDEL)
 5556 CØNTINUE                                                                 1900280
      MSET=2                                                                   1900290
      IF (MAGØUT) 305,101,101                                                  1900300
  101 IF(MAGIN) 21, 27, 14                                                     1900310
   27 K = 0                                                                    1900320
      DØ 202 I = 1,NEQNS                                                       1900330
  202 YNEW(I)  = YPRED(I)                                                      1900340
   21 K = K +1                                                                 1900350
      KKNT = K                                                                 1900351
  210 DØ  2  I = 1,NEQNS                                                       1900360
      GØ TØ (9,6,7,4,11),K                                                     1900370
    9 FWDEL(I) = YDØT(I)                                                       1900380
      GØ TØ 105                                                                1900390
    6 TBDEL(I) = YDØT(I)                                                       1900400
      GØ TØ 105                                                                1900410
    7 TBDEL(I) = TBDEL(I) + YDØT(I)                                            1900420
  105 YPRED(I) = YNEW(I) + C(K)*DTIME*YDØT(I)                                  1900430
      GØ TØ (2,2,400),K                                                        1900440
  400 YCØRR(I) = YPRED(I)                                                      1900450
    2 CØNTINUE                                                                 1900460
      TIME     = TIME + D(K)*DTIME                                             1900470
   99 MAGØUT   = 0.0                                                           1900480
  264 RETURN                                                                   1900490
    4 DØ  8  I = 1,NEQNS                                                       1900500
      YPRED(I) = YNEW(I) + DTIME*(FWDEL(I) + 2.*TBDEL(I) + YDØT(I))/6.         1900510
    8 YDEV(I)  = YCØRR(I) - YPRED(I)                                           1900520
      GØ TØ 99                                                                 1900530
   11 IF (DELTA)80, 5,80                                                       1900540
   80 DØ  13 I = 1,NEQNS                                                       1900550
      IF (EPSIL*ABS(YCØRR(I)) + ERR - ABS(YDEV(I))) 14,13,13                   1900560
```

```
 13 CØNTINUE
    IF (SIGB)15,15,205
205 SIGB = 0.0
    GØ TØ 5
 15 SIGB = 0.0
    DØ 207 I = 1,NEQNS
    IF (ERR  /100.+ DELTA*ABS(YCØRR(I)) - ABS(YDEV(I))) 5,207,207
207 CØNTINUE
    DTIME     = 2.*DTIME
  5 DØ 208 I = 1,NEQNS
208 YCØRR(I) = YPRED(I)
305 IF (DTAU) 19,30,19
 19 IF (TAU - TIME)20,20,27
 20 TAU = TAU + DTAU
 30 MAGØUT = 2
    GØ TØ 264
 14 DTIME = DTIME/2.0
 25 IF (K-3)48,26,26
 26 TIME  = TIME - DTIME - DTIME
    GØ TØ 47
 48 TIME  = TIME - DTIME
 47 SIGB      = +2.
    DØ 209 I = 1,NEQNS
209 YDØT(I) = FWDEL(I)
212 K         = 0
    GØ TØ 21
     END
```

```
C ..... RØUTINE **  TØBØR ** ABACUS UPDATED 07/07/72 .....              2700000
      SUBRØUTINE TØBAR (ST,KLUE2,NRØW,NRW,LL,ER,ES,E1,E2,HI,HØ,T,TII,   2600010
     1                  TØØ,TIK,TØK,DEGRES,G2,G3,TIME)                  2600020
      INTEGER SAVJTC,SAVSTP,Q,THICK
      INTEGER XN1,XN2,XN                                                2600040
      REAL*4 I2
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK                 2600060
      DØUBLE PRECISIØN YPRED,TIME                                       2600070
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)         2600080
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)                            2600090
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(2),NH           2600100
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)  2600110
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB 2600120
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE 2600130
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS            2600140
      CØMMØN /LASTEQ/ YPRED(16),YDØT(16),YASAVE(16),                    2600150
     1                YANTH,YAMTH,YAMPT,YANPT,YAØPH,YAQPH,YAQTH,YAJPH,  2600160
     2                S,SN,CS,SNSQ,CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,        2600170
     3                X1RØ,X1RØSQ,X1SNRØ,X1CSRØ,CN1RØ,SN1RØ,CS1RØ,      2600180
     4                X1R1,X1R2,CS1R1,CS1R2,SN1R1,X1R1SQ,R2SQ,RØ,BESQ,  2600190
     5   RØSQ,XNSQ,BETA,R1,R2,S1,R1DØT,R1SQ,                            2600200
     6                XNTTH,XNTPH,XMTTH,XMTPH,XFTHLD,XFPHLD,XFZELD,     2600210
     7 XMTHLD,XMPHLD,ETHET(2),EPHI(2),XGPT(2),ALPHTH(2),ALPHPH(2),       2600220
     8                XNUTP,XNUPT,XC11,XC22,XC15,XD33,XD22,XD21,XD12,   2600230
     9                XK11,XK12,XK21,XK22,XK33,XD11,                    2600240
     A                   M,I,SITIN,SITØUT,SIPIN,SIPØUT,TPTIN,TPTØUT,    2600250
     B             ZBRIN,ZBRØUT,SCRIPA,SCRIPI,SIFIN,SIFØUT,TZEPH,TZETH  2600260
     B                ,XNPHI,BETTA,ZETTA,SAVY(8),XC16                   2600270
      CØMMØN /SNILPS/ ANG,PSI(100),RAD(100),CUR1(100),CUR2(100),        2600280
     1       DR1DP(100),ZI(14),RI(14),NRZIN                             2600290
      DIMENSIØN ST(72,31)                                               2600300
      DATA A/-A   -/                                                    2600310
      IF (KBC.EQ.0) GØ TØ 500                                           2600320
      L = 1                                                             2600330
      IF (NLCASE.EQ.1) GØ TØ 800                                        2600340
      L = 3                                                             2600350
      SAVY(4) = ST(NRØW-1,LL)                                           2600360
      SAVY(5) = ST(NRØW,LL)                                             2600370
      SAVY(6) = 0.0                                                     2600380
  800 SAVY(1) = ST(NRØW-L,LL)                                           2600390
      L = L-1                                                           2600400
      SAVY(2) = ST(NRØW-L,LL)                                           2600410
      SAVY(3) = 0.0                                                     2600420
  500 CØNTINUE                                                          2600430
      GØTØ (771,772,773,774,775,776,7077),KGEØM                         2600440
C     GEØMETRY FØR ELIPSE(G3=ØFFSET DISTANCE )                          2600450
  771 A=G1                                                              2600460
      BE=G2                                                             2600470
      BETA = BE                                                         2600480
       BESQ=BE**2                                                       2600490
      ASQ=A**2                                                          2600500
      SN = DSIN(PHI)                                                    2600510
      CS = DCØS(PHI)                                                    2600520
      SNSQ = SN**2                                                      2600530
      CSSQ = CS**2                                                      2600540
      R2 = A*SQRT(1.0/(SNSQ+BESQ*CSSQ))                                 2600550
      R2SQ = R2**2                                                      2600560
      RØ=R2*SN                                                          2600570
      R1=R2*R2SQ*BESQ/ASQ                                               2600580
      BESQ=BE**2                                                        2600590
```

```
      R1DØT=0.0
      IF(KGEØM.EQ.1.AND.BETA.NE.1.0.AND.SN.NE.0.0)R1DØT=3.0*(R2*BETA/
     1A) **2*(CS/SNSQ)*(R1*SN-RØ)
      IF(SN.EQ. 0.0)GØ TØ 779
      R2 = R2-G3/SN
      R2SQ = R2**2
      RØ = RØ-G3
      GØ TØ 7775
  779 IF(G3 .EQ. 0.0)GØ TØ 7775
      R1DØT = 3.0*G3
      RØ = -G3
      GØ TØ 7775
C     GEØMETRY FØR ØGIVE
  772 R1=G1
      C=G2
      SN = DSIN(PHI)
      CS = DCØS(PHI)
      IF (SN.EQ.0.0) GØTØ 777
      R2=R1-C/SN
      GØTØ 778
  777 R2 = 1.0
  778 RØ = R1*SN-C
      R1DØT=0.0
      GØTØ 7775
C     GEØMETRY FØR CØNE
  773 CS = CØS(G1)
      SN=SIN(G1)
      S=PHI
      S1=1.0/S
      R2=CS*SN*PHI
      RØ=PHI*CS
      R1DØT=0.0
      GØTØ 7775
C     GEØMETRY FØR CYLINDER
  774 RØ = G1
      SN=1.0
      CS=1.0
      R1DØT=0.0
      GØTØ 7775
C   MØDIFIED  ELLIPSE
  775 XNEXP=G1
      A    =G2
      XN1=1.0+XNEXP
      XN2=1.0/XN1
      XN3=XN1+1.0
      XN4=XN3+1.0
      XN5=XN4/XN1
      SN = DSIN(PHI)
      CS = DCØS(PHI)
      R2= A*(2.0/(1.0+SN**XN1))**XN2
      R1=(A/2.0)*(R2/A)**XN3
      RØ=R2*SN
      R1DØT=-XN3*A*(SN**XNEXP*CS/4.0)*(2.0/(1.0+SN**XN1))**XN5
      GØTØ 7775
C     GENERAL GEØMETRY
  776 SN = DSIN(PHI)
      CS = DCØS(PHI)
      TAN = SN / CS
      SEC = 1.0 / CS
      IF (TIME.EQ.TIC) CALL TEMØEG
      ARG = PHI
```

```
      DØ 204 J=1,100                                                    2601210
      PHØ = PSI(J)                                                      2601220
      IF (ANG.EQ.A) IF (ARG-PHØ) 221,223,204                            2601230
      IF (PHØ-ARG) 221,223,204                                          2601240
  221 IF (J-1) 8502,8502,224                                            2601250
  204 CØNTINUE                                                          2601260
      GØ TØ 8503                                                        2601270
  223 RØ = RAD(J)                                                       2601280
      R1 = CUR1(J)                                                      2601290
      R2 = CUR2(J)                                                      2601300
      R1DØT = DR1DP(J)                                                  2601310
      GØ TØ 7775                                                        2601320
 8502 NERRØR = 41                                                       2601330
      GØ TØ 8888                                                        2601340
 8503 NERRØR = 42                                                       2601350
 8888 NIX = 1                                                           2601360
      GØ TØ 8889                                                        2601370
  224 SUB1 = ARG-PSI(J-1)                                               2601380
      SUB2 = PSI(J)-PSI(J-1)                                            2601390
      RØ = RAD(J-1)+(RAD(J)-RAD(J-1))*SUB1/SUB2                         2601400
      R1 = CUR1(J-1)+(CUR1(J)-CUR1(J-1))*SUB1/SUB2                      2601410
      R2 = CUR2(J-1)+(CUR2(J)-CUR2(J-1))*SUB1/SUB2                      2601420
      R1DØT = DR1DP(J-1)+(DR1DP(J)-DR1DP(J-1))*SUB1/SUB2                2601430
      GØTØ 7775                                                         2601440
C     ISØTENSØID GEØMETRY                                               2601450
 7077 CØNTINUE                                                          2601460
      SN = DSIN(PHI)                                                    2601470
      CS = DCØS(PHI)                                                    2601480
      A  = G1                                                           2601490
      R2 = A / SQRT(SN)                                                 2601500
      R1 = 0.5 * R2                                                     2601510
      RØ = R2 * SN                                                      2601520
      R1DØT = - ((A**2)*0.5)*(R1*CS)/RØ**2                              2601530
 7775 TAN=SN/CS                                                         2601540
      DEGRES  = 0.0                                                     2601550
      IF(IGEØM.EQ.1) DEGRES = PHI * 57.29578                            2601560
      RØSQ = RØ**2                                                      2601570
      XNSQ=XN**2                                                        2601580
      CN=CS*SN                                                          2601590
      X1CS=1.0/CS                                                       2601600
      TN=SN/CS                                                          2601610
      X1RØ=1.0/RØ                                                       2601620
      X1RØSQ=1.0/RØ**2                                                  2601630
      X1CSRØ=1.0/(CS*RØ)                                                2601640
      CN1RØ=CN/RØ                                                       2601650
      SN1RØ=SN/RØ                                                       2601660
      CS1RØ=CS/RØ                                                       2601670
      SNSQ=SN**2                                                        2601680
      CSSQ=CS**2                                                        2601690
      IF(KGEØM.EQ.4.ØR.KGEØM.EQ.3) GØTØ 79                              2601700
      R1SQ = R1**2                                                      2601710
      R2SQ = R2**2                                                      2601720
      X1SN=1.0/SN                                                       2601730
      X1SNRØ=1.0/(SN*RØ)                                                2601740
      X1R1=1.0/R1                                                       2601750
      X1R2=1.0/R2                                                       2601760
      CS1R1=CS/R1                                                       2601770
      CS1R2=CS/R2                                                       2601780
      SN1R1=SN/R1                                                       2601790
      X1R1SQ=1.0/R1**2                                                  2601800
   79 XNTTH=0.0                                                         2601810
```

```
      XNTPH=0.0
      XMTTH=0.0
      XMTPH=0.0
C
C     COMPUTATION OF K AND D FOR MATERIAL PROPETY INPUT
C
      GO TO (711,600,711,32,33,34,35,36,37,28,29,30),ISTTAB
C     THICK
  600 GO TO (703,702,701,701),THICK
  701 HO= ST(4,LL)
  702 T = ST(3,LL)
  703 HI= ST(2,LL)
      GO TO 40
C     ST11,ST12,ST13
   30 HO= ST(14,LL)
   29 T = ST(13,LL)
   28 HI= ST(12,LL)
      GJPH= ST(2,LL)
      GJTH= ST(3,LL)
      APH = ST(4,LL)
      ATH = ST(5,LL)
      CPH = ST(6,LL)
      CTH = ST(7,LL)
      XIPH = ST(8,LL)
      XITH= ST(9,LL)
      SPH = ST(10,LL)
      STH = ST(11,LL)
      GO TO 40
C     RWAF1,RWAF2,RWAF3
   34 HO = ST(10,LL)
   33 T = ST(9,LL)
   32 HI = ST(8,LL)
      APH = ST(2,LL)
      CPH = ST(3,LL)
      XIPH= ST(4,LL)
      SPH = ST(5,LL)
      BETTA=ST(6,LL)
      ZETTA = ST(7,LL)
      ATH = APH
      CTH = CPH
      XITH= XIPH
      STH = SPH
      GO TO 40
C     ISG1,ISG2,ISG3
   37 HO = ST(9,LL)
   36 T = ST(8,LL)
   35 HI = ST(7,LL)
      APH = ST(2,LL)
      CPH = ST(3,LL)
      XIPH = ST(4,LL)
      SPH = ST(5,LL)
      BETTA = ST(6,LL)
      ATH = APH
      CTH = CPH
      XITH = XIPH
      STH = SPH
      GO TO 40
C     ST10,RWAF
C     RANKIN=THSTND MEANS INTERPOLATE,COMPUTE NTEMP,MTEMP
C     RANKIN=NOTHRM MEANS DO NOT INTERPOLATE,DO NOT COMPUTE NTEMP,NTEMP
C     RANKIN=THCNST MEANS DO NOT AVERAGE, BUT INTERPOLATE,COMPUTE
```

```
C                                                           NTEMP, MTEMP    2602430
C     RANKIN=THINHØ MEANS INTERPØLATE,BUT DØ NØT CØMPUTE NTEMP,MTEMP       2602440
C                                                                           2602450
  711 CØNTINUE                                                              2602460
      XK11=ST(2,LL)                                                         2602470
      XK12=ST(3,LL)                                                         2602480
      XK22 = ST(4,LL)                                                       2602490
      XK33 = ST(5,LL)                                                       2602500
      XD11 = ST(6,LL)                                                       2602510
      XD12 = ST(7,LL)                                                       2602520
      XD22 = ST(8,LL)                                                       2602530
      XD33 = ST(9,LL)                                                       2602540
      XC11 = ST(10,LL)                                                      2602550
      XC22 = ST(11,LL)                                                      2602560
      XC15 = ST(12,LL)                                                      2602570
      XC16 = ST(13,LL)                                                      2602580
      XK21 = XK12                                                           2602590
      XD21 = XD12                                                           2602600
      GØ TØ 103                                                             2602610
C                                                                           2602620
   40 CØNTINUE                                                              2602630
      TEMP3= (1.0-XNUPT * XNUTP)                                            2602640
      PERM= TEMP3                                                           2602650
      E1= (ETHET(1)+ EPHI(1))/2.                                            2602660
      E2= (ETHET(2)+ EPHI(2))/2.                                            2602670
      ES1= E1+E2                                                            2602680
      GØ TØ (42,47,49,41),THICK                                             2602690
   41 GØ TØ (103,42,103,42,47,49,42,47,49,42,47,49),ISTTAB                  2602700
C                                                                           2602710
C     SINGLE SHEET                                                          2602720
C                                                                           2602730
   42 TEMP1= ETHET(1) * HI                                                  2602740
      TEMP2= TEMP1 * HI**2                                                  2602750
      XK11= TEMP1/TEMP3                                                     2602760
      XD11= TEMP2/(12.0* TEMP3)                                             2602770
      TEMP1= EPHI(1)* HI                                                    2602780
      TEMP2= TEMP1*HI**2                                                    2602790
      XK22= TEMP1/TEMP3                                                     2602800
      XD22= TEMP2/(12.0* TEMP3)                                             2602810
      XK33= XGPT(1)* HI                                                     2602820
      XD33= XK33*HI**2/12.0                                                 2602830
      GØ TØ 55                                                              2602840
C                                                                           2602850
C     EQUAL SHEETS                                                          2602860
C                                                                           2602870
   47 EPSUM= EPHI(1)+ EPHI(2)                                               2602880
      ETSUM= ETHET(1)+ ETHET(2)                                             2602890
      XK11= ETSUM * HI/PERM                                                 2602900
      XK22= EPSUM * HI/PERM                                                 2602910
      XK33= HI*(XGPT(1)+ XGPT(2))                                           2602920
      ZBRIN = (HI*(E1+3.0*E2)+2.0*E2*T)/(2.0*ES1)                           2602930
      ZBRØUT = (HI*(E2+3.0*E1)+2.0*E1*T)/(2.0*ES1)                          2602940
      ZBHIN= (ZBRIN- HI/2.0)**2                                             2602950
      ZBHØUT=(ZBRØUT-HI/2.0)**2                                             2602960
      XD33= (HI**3*(XGPT(1)+XGPT(2)))/12.0+ HI*(XGPT(1)* ZBHIN              2602970
     1     +  XGPT(2)* ZBHØUT)                                              2602980
      XD11=(XK11* HI**2)/12.+ HI*( ETHET(1) * ZBHIN + ETHET(2)*ZBHØUT)      2602990
     1/PERM                                                                 2603000
      XD22=(XK22* HI**2)/12.+ HI*( EPHI(1) * ZBHIN + EPHI(2)* ZBHØUT)       2603010
     1/PERM                                                                 2603020
      GØ TØ 55                                                              2603030
```

```
C
C     UNEQUAL FACE SHEETS
C
   49 CØNTINUE
      ZBRIN =((E1*HI**2)+(E2*HØ**2) +(2.0*E2*HØ*HI) +(2.0*E2*HØ*T)) /
     1 (2.0*(E1*HI+E2*HØ))
      ZBRØUT=((E1*HI**2)+(E2*HØ**2) +(2.0*E1*HØ*HI) +(2.0*E1*HI*T)) /
     1 (2.0*(E1*HI+E2*HØ))
      ZBHIN =(ZBRIN-HI/2.0)**2
      ZBHØUT =(ZBRØUT-HØ/2.0)**2
      XK11= (ETHET(1)* HI + ETHET(2)* HØ)/PERM
      XK22= (EPHI(1) * HI + EPHI(2) * HØ)/PERM
      XK33= XGPT(1)*HI + XGPT(2) * HØ
      XD33 = (XGPT(1)*HI**3+XGPT(2)*HØ**3)/12.+HI*(XGPT(1)*ZBHIN)+
     1 XGPT(2)*ZBHØUT*HØ
      D11 =  (ETHET(1)*HI**3 + ETHET(2)*HØ**3)/12.
      XD11=(D11+ (HI*ETHET(1)*ZBHIN)    + (HØ*ETHET(2)*ZBHØUT))/PERM
      D22 =  (EPHI(1)* HI**3 + EPHI(2)*HØ**3)/12.
      XD22= ( D22 +(HI*EPHI(1)*ZBHIN) + (HØ*EPHI(2)* ZBHØUT)) /PERM
C
C     DETERMINE CØMPLETE CØNSTANTS DEPENDENT ØN REINFØRCEMENT CLUE
C
   55 CØNTINUE
      IF(ISTTAB .EQ.2)GØ TØ 103
      EASTH=ER*ATH/STH
      EASPH=ES*APH/SPH
      EISPH= ES* XIPH/SPH
      EISTH= ER* XITH/STH
      GØ TØ (58,60,100),KLUE2
C
C     ST CLUE(10,11,12)
C
   58 CØNTINUE
      XK12= XK11*XNUTP
      XK11= XK11+ EASTH
      XK22= XK22+ EASPH
      XC11= EASTH*CTH
      XC22= EASPH*CPH
      XD22 = -XD22-EISPH
      XD33= XD33 + GJPH/(4.0*SPH)+ GJTH/(4.0*STH)
      XD12= -XD11*XNUTP
      XD11= -XD11- EISTH
      XK21 = XK12
      XD21 = XD12
      GØ TØ 103
C     RAF CLUE(1,2,3)
C
   60 CØNTINUE
      SINB =SIN(BETTA)
      CØSB =CØS(BETTA)
      SN2TØ4 = 2*(SINB**4.)
      D= STH*(CØSB+SINB)
      ED = ER*ATH/D
      SINB2= SINB**2.
      HL = 2.0*(ABS(ZETTA)-ABS(CTH))
      I2=(ATH**3.)/(3* HL**2)
   95 XC22 = 2.0*CTH*CØSB**3*ED
      XC15 = 2.0*CTH*CØSB*SINB2*ED
      XC16 = XC15
      GRI=  ER* I2/(2.0*(1.0 + XNUTP)*D)
      XC11 = CTH*SN2TØ4/CØSB*ED
```

```
      EDI = ER*XITH/D
      SN4TØ2 = 4.*SINB2
      XD22 = -XD22-2.0*CØSB**3*EDI-SN4TØ2*CØSB*GRI
      TB= 2.0* BETTA
      XD33 = XD33+((4.0*CØS(TB)*
     1*2*GRI)/ CØSB) + (2.0*CØSB*SINB2*EDI)
      XD12 = -XD11*XNUTP-(2.0*CØSB
     1*SINB2*EDI)-(SN4TØ2*CØSB*GRI )
      XK12= XK11*XNUTP + (2.0*CØSB*SINB2*ED)
      XK22=XK22+(2*CØSB**3*ED)
      XK33=XK33+(2*CØSB*SINB2*ED)
      XK11=XK11+(SN2TØ4*ED/CØSB)
      XD11 = -XD11-SN2TØ4*EDI/CØSB-(
     1 SN4TØ2*CØSB*GRI)
      XK21 = XK12
      XD21 = XD12
      GØ TØ 103
C
C     ISG CLUE(7,8,9)
C
  100 CØNTINUE
      SNB =SIN(BETTA)
      CSB =CØS(BETTA)
      TBETTA= 2.0*BETTA
      CS2B= CØS(TBETTA)
      ØNEC2B=(1.0+ CS2B)/2.
      SCB2  =(SNB-CS2B*SNB + 2.)/(2.0*CSB)
      SN2B  =SIN(TBETTA) /2.
      XK12=XK11*XNUTP + (EASTH*SNB*ØNEC2B/CSB)
      XK11=XK11+ EASTH*SCB2
      XK22=XK22+ EASTH*(CSB/SNB*ØNEC2B)
      XK33=XK33+ EASTH* SN2B
      XC11=      (EASTH*CTH* SCB2 )
      XC15=EASTH*CTH*( SNB* ØNEC2B/CSB )
      XC16=EASTH*CTH*SN2B
      XC22= EASTH*CTH* (CSB/SNB * ØNEC2B)
      XD12=-XD11*XNUTP- EISTH*(SNB*ØNEC2B/CSB)
      XD11=-XD11- EISTH*SCB2
      XD22 = -XD22-EISTH*(CSB/SNB*ØNEC2B)
      XD33= XD33+ EISTH*SN2B
      XK21 = XK12
      XD21 = XD12
C
C
C
  103 CØNTINUE
C
      GØTØ (716,714,715,714),KELVIN
  716 TII = ST(NRW+1,LL)
      TIK = ST(NRW+2,LL)
      TØK = ST(NRW+3,LL)
      TØØ = ST(NRW+4,LL)
      GØ TØ 717
  715 TII = ST(NRW+1,LL)
      TIK = TII
      TØK = TII
      TØØ = TII
C
  717 TEMP11= ALPHTH(1)+ XNUTP * ALPHPH(1)
      TEMP12= ALPHTH(2)+ XNUTP * ALPHPH(2)
      TEMP21= ALPHPH(1)+ XNUPT * ALPHTH(1)
```

```
      TEMP22= ALPHPH(2)+ XNUPT * ALPHTH(2)
      TEMP3 = 1-XNUPT*XNUTP
      TEMP4 = HI/4.0
      ETHK1=  ETHET(1)*TEMP11/TEMP3
      TEMP5 = HI**2/24.0
      ETHK2 = ETHET(2)*TEMP12/TEMP3
      TEMP61= TII+ TIK-2* TEFREE
      TEMP62= T00+ T0K-2* TEFREE
      TEMP71= 2.0* TII +TIK-3*TEFREE
      TEMP72= 2.0* T00 +T0K-3*TEFREE
      EPHK1 = EPHI(1)*TEMP21/TEMP3
      EPHK2 = EPHI(2)*TEMP22/TEMP3
      GØ TØ (811,812,813,814),THICK
C
C
  811 XNTTH= ETHK1   *           TEMP4 * (TEMP61+ TEMP62)
      XNTPH= EPHK1   *           TEMP4 * (TEMP61 + TEMP62)
      XMTTH= ETHK1   *           TEMP5 * (TEMP71- TEMP72)
      XMTPH= EPHK1   *           TEMP5 * (TEMP71 - TEMP72)
      GØ TØ 714
  812 TI = (HI*(E2-E1)+2.0*E2*T)/(2.0*(E1+E2))
      TØ = (HI*(E1-E2)+2.0*E1*T)/(2.0*(E1+E2))
      TEMP8= HI/2.0
      XNTTH = ETHK1   *         TEMP8*TEMP61 + ETHK2   *       TEMP8*
     1TEMP62
      XNTPH = EPHK1  *          TEMP8*TEMP61 + EPHK2   *       TEMP8*
     1TEMP62
      XMTTH =(ETHK1 *  TEMP8 * (HI*TEMP71/3.0+ TI*TEMP61)) - (ETHK2 *
     1 TEMP8*(HI*TEMP72/3.0+TØ*TEMP62))
      XMTPH =(EPHK1 *  TEMP8 * (HI*TEMP71/3.0+ TI*TEMP61)) - (EPHK2 *
     1 TEMP8*(HI*TEMP72/3.0+TØ*TEMP62))
      GØ TØ 714
  813 TI = (E2*HØ**2-E1*HI**2+2.0*E2*HØ*T)/(2.0*(E1*HI+E2*HØ))
      TØ = (E1*HI**2-E2*HØ**2+2.0*E1*HI*T)/(2.0*(E1*HI+E2*HØ))
      XNTTH = ETHK1*0.5*(HI*TEMP61)+ETHK2*0.5*(HØ*TEMP62)
      XNTPH= EPHK1*0.5*(HI*TEMP61)+ EPHK2*0.5*(HØ*TEMP62)
      XMTTH = ETHK1*0.5*(HI**2*TEMP71/3.0+TI*HI*TEMP61)-ETHK2*0.5*(HØ
     1**2*TEMP72/3.+ TØ*HØ*TEMP62)
      XMTPH = EPHK1*0.5*(HI**2*TEMP71/3.0+TI*HI*TEMP61)-EPHK2*0.5*(HØ
     1**2*TEMP72/3.+ TØ*HØ*TEMP62)
      GØ TØ 714
  814 TEMP10=((-XK11*XD11)**.5)/(48.0**.5)
      TEM11 =((-XK22*XD22)**.5)/(48.0**.5)
      XNTTH =(XK11/4.0 *TEMP11)* TEMP61 + (XK11/4.0*TEMP12) * TEMP62
      XNTPH =(XK22/4.0 *TEMP21)* TEMP61 + (XK22/4.0*TEMP22) * TEMP62
      XMTTH =  TEMP10*(TEMP11*TEMP71 - TEMP12* TEMP72)
      XMTPH =  TEM11 *(TEMP21*TEMP71 - TEMP22* TEMP72)
  714 CØNTINUE
 8889 RETURN
      END
```

```
C ..... RØUTINE ** TEMØEG ** ABACUS UPDATED 07/07/72 .....
      SUBRØUTINE TEMØEG
C     THIS SUBRØUTINE CALCULATES THE GEØMETRY FØR A SHELL SEGMENT.
C     THE INPUT VARIABLES ARE . . .
C              RI(I) - - DISTANCE FRØM AXIS ØF REV. TØ PØINTS
C                        ØN SHELL MERIDIAN.
C              ZI(I) - - DISTANCE ALØNG AXIS ØF REV. TØ THE
C                        INTERSECTIØN ØF THE CØRRESPØNDING RI(I) AND
C                        THE AXIS ØF REV.
C              NRZIN - - NUMBER ØF (RI,ZI) PAIRS READ AS INPUT.
C
      CØMMØN /SNILPS/ ANG,PSI(100),RAD(100),CUR1(100),CUR2(100),
     1       DRIDP(100),ZI(14),RI(14),NRZIN
      DIMENSIØN CI(4,13),DRDZ(14),SØUT(14),S(101),RADD(100)
C
      FUN(ARG) = SQRT(1.0 + ARG**2)
C
      RADS = 3.1415926/180.0
      DATA B/-B    -/
      AMULT = 1.0
      IF (ANG.EQ.B) AMULT = -1.0
C
C     PASS SPLINE CURVE THRØUGH INPUT PØINTS ØN SHELL MERIDIAN, AND
C     CØMPUTE DR/DZ AT THESE PØINTS.
C
      CALL PLYCØ (ZI,RI,NRZIN,CI)
      NDELZ = NRZIN - 1
      DØ 60 I=1,NRZIN
      CALL PLYNE (ZI,RI,NRZIN,CI,ZI(I),FAKE1,DRDZ(I),FAKE2)
   60 CØNTINUE
C
C     CØMPUTE MERIDIØNAL ARC LENGTH TØ INTERPØLATED PØINTS BY
C     NUMERICAL INTEGRATIØN (SIMPSØNS RULE).  SINCE SIMPSØNS RULE
C     REQUIRES AN EVEN NUMBER ØF PARTITIØNS, INTERPØLATE A PØINT
C     MIDWAY BETWEEN EACH PAIR ØF PØINTS USING SUBRØUTINE  PLINE.
C
      SØUT(1) = 0.
      DØ 70 I=1,NDELZ
      DZ2=(ZI(I+1)-ZI(I))/2.0
      DZ6=DZ2/3.0
      CALL PLYNE (ZI,RI,NRZIN,CI,ZI(I)+DZ2,FAKE1,DRDZM,FAKE2)
      SØUT(I+1) = SØUT(I) + DZ6*(FUN(DRDZ(I)) + 4.0*FUN(DRDZM) +
     1            FUN(DRDZ(I+1)))
   70 CØNTINUE
C
C     USE SPLICØ TØ REPRESENT RI(I) AS A FUNCTIØN ØF SØUT(I).  THEN USE
C     SPLINE TØ INTERPØLATE RADD AND CØRRESPØNDING DERIVATIVES.  FRØM
C     THESE, CØMPUTE THE TWØ PRINCIPAL RADII ØF CURVATURE,
C       CUR1 = 1/R1
C       CUR2 = 1/R2
C
      ØLDH1 = SØUT(NRZIN)/99.0
      CALL PLYCØ (SØUT,RI,NRZIN,CI)
      DØ 110 I=1,100
      S(I) = FLØAT(I-1)*ØLDH1
      CALL PLYNE (SØUT,RI,NRZIN,CI,S(I),RAD(I),RADD(I),RADD2)
      IF (ABS(RADD(I)).GT.1.0) RADD(I)=1.0
      FACTØR = SQRT(1.0-RADD(I)**2)
      CUR1(I) = -RADD2/FACTØR
      CUR2(I) = FACTØR/RAD(I)
```

```
110 CØNTINUE
    DØ 180 J=1,100
    CØSPSI = AMULT*RADD(J)
    PSI(J) = ARCØS(CØSPSI)
    SINPSI = -AMULT*RAD(J)*CUR2(J)
    IF (ANG.EQ.B) GØ TØ 179
    PSI(J) = 2.0*3.1415926-PSI(J)
179 CØNTINUE
    CUR1(J) = -AMULT/CUR1(J)
    CUR2(J) = -AMULT/CUR2(J)
    IF (J.EQ.1) GØ TØ 180
    I = 1
    IF (J.EQ.2) GØ TØ 181
    I = 2
181 IF (ANG.EQ.B) GØ TØ 190
    DR1DP(J-1) = (CUR1(J)-CUR1(J-I))/(PSI(J)-PSI(J-I))
    GØ TØ 180
190 DR1DP(J-1) = (CUR1(J-I)-CUR1(J))/(PSI(J-I)-PSI(J))
180 CØNTINUE
    DR1DP(100) = DR1DP(99)
    DØ 42 J=1,100
    DR1DP(J) = DR1DP(J)*0.1
 42 CØNTINUE
    RETURN
    END
```

```
C ..... RØUTINE ** PLYCØ  ** ABACUS UPDATED 05/20/72 .....
      SUBRØUTINE PLYCØ (X,Y,M,C)
C     SUBRØUTINE TØ DETERMINE C(1,K),C(2,K),C(3,K) AND C(4 K).
      DIMENSIØN X(14),Y(14),A(14,3),B(14),Z(14)
      DIMENSIØN D(13),P(13),E(13),C(4,13)
      MM = M-1
      DØ 10 K=1,MM
      D(K) = X(K+1) - X(K)
      P(K) = D(K)/6.0
   10 E(K) = (Y(K+1)-Y(K))/D(K)
      DØ 20 K=2,MM
   20 B(K) = E(K) - E(K-1)
      A(1,2) = -1.0-D(1)/D(2)
      A(1,3) = D(1)/D(2)
      A(2,3) = P(2)-P(1)*A(1,3)
      A(2,2) = 2.0*(P(1)+P(2)) - P(1)*A(1,2)
      A(2,3) = A(2,3)/A(2,2)
      B(2) = B(2)/A(2,2)
      DØ 30 K=3,MM
      A(K,2) = 2.0*(P(K-1)+P(K))-P(K-1)*A(K-1,3)
      B(K) = B(K)-P(K-1)*B(K-1)
      A(K,3) = P(K)/A(K,2)
   30 B(K) = B(K)/A(K,2)
      Q = D(M-2)/D(M-1)
      A(M,1) = 1.0+Q+A(M-2,3)
      A(M,2) = -Q-A(M,1)*A(M-1,3)
      B(M) = B(M-2)-A(M,1)*B(M-1)
      Z(M) = B(M)/A(M,2)
      MN = M-2
      DØ 40 I=1,MN
      K = M-I
   40 Z(K) = B(K)-A(K,3)*Z(K+1)
      Z(1) = -A(1,2)*Z(2)-A(1,3)*Z(3)
      DØ 50 K=1,MM
      Q = 1.0/(6.0*D(K))
      C(1,K) = Z(K)*Q
      C(2,K) = Z(K+1)*Q
      C(3,K) = Y(K)/D(K)-Z(K)*P(K)
   50 C(4,K) = Y(K+1)/D(K)-Z(K+1)*P(K)
      RETURN
      END
```

```
C ..... RØUTINE ** PLYNE  ** ABACUS UPDATED 05/20/72 .....
      SUBRØUTINE PLYNE (X,Y,M,C,XINT,YINT,DYDX,D2YDX2)
C     SUBRØUTINE FØR SPLINE FIT INTERPØLATIØN IN THE TABLE ØF VALUES
C     (X1,Y1) TØ (XM,YM), WHERE M MAY BE AS LARGE AS 100,  HERE THE
C     CØNSTANTS C(1,K),C(2,K),C(3,K) AND C(4,K) ARE ALREAD  CØMPUTED
C     AND STØRED.
C     SUBRØUTINE ALSØ CØMPUTES DY/DX AND D2Y/DX2 AT XINT.
      DIMENSIØN X(14),Y(14),C(4,13)
      IF (XINT-X(1)) 80,10,20
   10 YINT = Y(1)
      K=1
      GØ TØ 70
   20 K = 1
   30 IF (XINT-X(K+1)) 60,40,50
   40 YINT = Y(K+1)
      GØ TØ 70
   50 K = K + 1
      IF (M-K) 80,80,30
   60 YINT = (X(K+1) - XINT)*(C(1,K)*(X(K+1)-XINT)**2+C(3,K))
      YINT = YINT + (XINT-X(K))*(C(2,K)*(XINT-X(K))**2+C(4,K))
   70 DYDX=-3.0*(C(1,K)*(X(K+1)-XINT)**2-C(2,K)*(XINT-X(K))**2)
     1     -C(3,K)+C(4,K)
      D2YDX2=6.0*(C(1,K)*(X(K+1)-XINT)+C(2,K)*(XINT-X(K)))
      RETURN
   80 WRITE (6,90)
   90 FØRMAT (31H ØUT ØF RANGE FØR INTERPØLATIØN)
      RETURN
      END
```

SUBROUTINES ODE1 AND ODE2

Subroutine LEBEGE calls either ODE1 or ODE2, as necessary, and various geometric and trigonometric clues, as well as the predicted values of the variables for the differential equations, are passed to this subprogram via label common area LASTEQ.

The equations in ODE1 and ODE2 are identical to those in subroutines DIF1 and DIFF2 respectively, with the addition of the auxiliary equations for YAQPH, and YAQTH. Subroutines ODE1 and ODE2 perform the final integration for each segment in the structure utilizing the initial conditions previously obtained, and return these values to LEBEGE via label common area LASTEQ.

The ODE1, ODE2 flow charts are identical to the DIF1, DIFF2 flow charts, respectively.

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1)
YANPT	$N_{\phi\theta}$
YAQPH	Q_{ϕ}
YAQTH	Q_{θ}
YAOPH	Ω_{ϕ}

```
C ..... RØUTINE **D19      ** ABACUS UPDATED 07/07/72 .....                2000000
      SUBRØUTINE ØDE1(XFPHL1,XFZEL1,XFPHL2,XFZEL2)
      INTEGER SAVJTC,SAVSTP,Q,THICK
      INTEGER XN1,XN                                                       2000030
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK                    2000040
      DØUBLE PRECISIØN YPRED                                               2000050
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)            2000060
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)                               2000070
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(2),NH              2000080
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)     2000090
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB    2000100
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE    2000110
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS               2000120
      CØMMØN /LASTEQ/ YPRED(16),YDØT(16),YASAVE(16),                       2000130
     1               YANTH,YAMTH,YAMPT,YANPT,YAØPH,YAQPH,YAQTH,YAJPH,      2000140
     2               S,SN,CS,SNSQ,CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,            2000150
     3               X1RØ,X1RØSQ,X1SNRØ,X1CSRØ,CN1RØ,SN1RØ,CS1RØ,          2000160
     4               X1R1,X1R2,CS1R1,CS1R2,SN1R1,X1R1SQ,R2SQ,RØ,BESQ,      2000170
     5   RØSQ,XNSQ,BETA,R1,R2,S1,R1DØT,R1SQ,                               2000180
     6               XNTTH,XNTPH,XMTTH,XMTPH,XFTHLD,XFPHLD,XFZELD,         2000190
     7  XMTHLD,XMPHLD,ETHET(2),EPHI(2),XGPT(2),ALPHTH(2),ALPHPH(2),        2000200
     8               XNUTP,XNUPT,XC11,XC22,XC15,XD33,XD22,XD21,XD12,       2000210
     9               XK11,XK12,XK21,XK22,XK33,XD11,                        2000220
     A                  M,I,SITIN,SITØUT,SIPIN,SIPØUT,TPTIN,TPTØUT,        2000230
     B             ZBRIN,ZBRØUT,SCRIPA,SCRIPI,SIFIN,SIFØUT,TZEPH,TZETH     2000240
     C , XNPHI,BETTA,ZETTA,SAVY(8),XC16                                    2000250
      EQUIVALENCE (XNL(1),X1),(XNL(2),X2)                                  2000260
      K = 0                                                                2000270
      IF (KBC.EQ.0.AND.NH.EQ.0) K = 1                                      2000280
      IF(ISTTAB.EQ.1)  GØ TØ 7786                                          2000340
      IF(ISTTAB.GE.10)GØ TØ 7786                                           2000350
C     THE FØLLØWING EQUATIØNS ARE THE -THICK- SET                          2000360
      GØ TØ (151,152,153),IGEØM                                            2000370
C   EQUATIØNS FØR SHELLS ØF REVØLUTIØN  ( PHI  CØØRDINATE )                2000380
  151 YANTH     = XNUPT*YPRED(I+1)+(XK11-XNUPT**2*XK22)*(XN*YPRED(I+4)+    2000390
     1            YPRED(I+5)*CS-YPRED(I+6)*SN)*X1RØ+K*(XNUPT*XNTPH-        2000400
     2            XNTTH)                                                   2000410
      YAMTH     = XNUPT*YPRED(I+3)-(XD11-XNUPT**2*XD22)*X1RØ*(X1RØ*(XN*    2000420
     1            YPRED(I+4)*SN-XNSQ*YPRED(I+6))+YPRED(I+7)*CS)+K*         2000430
     2            (XNUPT*XMTPH-XMTTH)                                      2000440
      YAØPH     = XN*YPRED(I+6)*X1RØ-YPRED(I+4)*SN1RØ                      2000450
      YAMPT     = (-1.0/((RØ/XD33)+(SNSQ*X1RØ/XK33)))*(-2.0*XN*            2000460
     1            YPRED(I+7)+YPRED(I+4)*(CS1R1-CN1RØ)+XN*YPRED(I+5)*       2000470
     2            (SN1RØ+X1R1)+2.0*XN*YPRED(I+6)*CS1RØ+YPRED(I)*SN/        2000480
     3            XK33+SN*YAØPH*(X1*SAVY(3)+X2*SAVY(6)))                   2000490
      YAJPH     = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))            2000500
     1            -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))                      2000510
      YANPT     = YPRED(I)+YAMPT*SN1RØ                                     2000520
      YDØT(I+4) = R1*(YPRED(I+4)*CS1RØ+XN*YPRED(I+5)*X1RØ+YPRED(I)/XK33+   2000530
     1            YAMPT*SN1RØ/XK33)+R1*YAØPH*(X1*SAVY(3)+X2*SAVY(6))       2000540
      YDØT(I)   = R1*(-2.0*YPRED(I)*CS1RØ+XN*YANTH*X1RØ-XN*YAMTH*SN*       2000550
     1            X1RØSQ-YAMPT*CS1RØ*(X1R1-SN1RØ))-R1*K*(XFTHLD+XMPHLD*    2000560
     2            SN1RØ)-(YDØT(I+4)*(X1*XFPHL1+X2*XFPHL2)+R1*YAØPH*        2000570
     3            (X1*XFZEL1+X2*XFZEL2))-R1*SN1RØ*(YAØPH*(X1*SAVY(1)+      2000580
     4            X2*SAVY(4))-YANPT*(X1*SAVY(3)+X2*SAVY(6)))               2000590
      YDØT(I+5) = R1*(YPRED(I+6)*X1R1+(1.0/(XK22-XNUTP**2*XK11))*          2000600
     1            (YPRED(I+1)-XNUTP*YANTH+K*(XNTPH-XNUTP*XNTTH)))          2000610
     2            -R1*YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))                   2000620
      EPSITH    = X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)         2000630
      EPSIPH    = X1R1*(YDØT(I+5)-YPRED(I+6))+YPRED(I+7)*(X1*SAVY(3)+      2000640
```

```
     1            X2*SAVY(6))
      YDØT(I+1) = R1*(CS1RØ*(YANTH-YPRED(I+1))-XN*X1RØ*(YPRED(I)+
     1            YAMPT*(SN*X1RØ+X1R1))+YPRED(I+2)*X1R1)-R1*K*XFPHLD
     2            -R1*((EPSITH+EPSIPH)*(X1*XFPHL1+X2*XFPHL2)-YPRED(I+7)*
     3            (X1*XFZEL1+X2*XFZEL2))
      YDØT(I+2) = R1*(-YPRED(I+2)*CS1RØ-YANTH*SN1RØ-YPRED(I+1)*X1R1
     1            +XNSQ*YAMTH*X1RØSQ-2.0*XN*YAMPT*CS*X1RØSQ)+R1*K*
     2            (XN*XMPHLD*X1RØ-XFZELD)-R1*((EPSITH+EPSIPH)*(X1*
     3            XFZEL1+X2*XFZEL2)+YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2))
     4            -R1*X1RØ*XN*(YANPT*(X1*SAVY(3)+X2*SAVY(6))-YAØPH*
     5            (X1*SAVY(1)+X2*SAVY(4)))
      YDØT(I+3) = R1*(YAMTH*CS1RØ-YPRED(I+3)*CS1RØ-2.0*XN*YAMPT*X1RØ+
     1            YAJPH+K*XMTHLD)
      YDØT(I+6) = R1*(YPRED(I+7)-YPRED(I+5)*X1R1)
      YDØT(I+7) = R1*(1.0/(XD22-XNUTP**2*XD11))*(-YPRED(I+3)+XNUTP*
     1            YAMTH-K*(XMTPH-XNUTP*XMTTH))
      GØTØ 9005
C     EQUATIØNS FØR CØNE
  152 YANTH=XNUPT*YPRED(I+1)+(XK11-XNUPT**2*XK22)*(X1CS/S)*(XN*YPRED(I+4
     1            )+YPRED(I+5)*CS-YPRED(I+6)*SN)+K*(XNUPT*XNTPH-XNTTH)
      YAMTH=XNUPT*YPRED(I+3)-(1.0/S)*X1CS*(XD11-XNUPT**2*XD22)*((1.0/S)*
     1       X1CS*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+YPRED(I+7)*CS)-
     2            K*(XMTTH-XNUPT*XMTPH)
      YAØPH      = XN*YPRED(I+6)*X1CS/S-YPRED(I+4)*TAN/S
      YAMPT=(-1.0/((S*CS/XD33)+(SN*TN/(XK33*S))))*(-2.0*XN*YPRED(I+7)-
     1       YPRED(I+4)*SN/S+XN*YPRED(I+5)*TN/S+2.0*XN*YPRED(I+6)/S+YPRED
     2            (I)*SN/XK33+SN*YAØPH*(X1*SAVY(3)+X2*SAVY(6)))
      YAJPH      = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
     1            -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT      = YPRED(I)+YAMPT*TAN/S
      YDØT(I+4)=(1.0/S)*(YPRED(I+4)+XN*YPRED(I+5)*X1CS+YAMPT*TN/XK33)
     1            +YPRED(I)/XK33+YAØPH*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I)   =-2.0*YPRED(I)/S+XN*YANTH*X1CS/S-XN*YAMTH*SN*X1CS**2/S**2
     1            +YAMPT*TAN/S**2-K*(XFTHLD+XMPHLD*TAN/S)-(YDØT(I+4)*
     2            (X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+X2*XFZEL2))-
     3            TAN/S*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*(X1*SAVY(3)
     4            +X2*SAVY(6)))
      YDØT(I+5) = (1.0/(XK22-XNUTP**2*XK11))*(YPRED(I+1)-XNUTP*YANTH+
     1            K*(XNTPH-XNUTP*XNTTH))-YPRED(I+7)*(X1*SAVY(3)+X2*
     2            SAVY(6))
      EPSITH     = (1.0/(S*CS))*(XN*YPRED(I+4)+CS*YPRED(I+5)-SN*
     1            YPRED(I+6))
      EPSIPH     = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I+1)= -YPRED(I+1)/S+YANTH/S-XN*YPRED(I)/(S*CS)-XN*YAMPT*SN/
     1            (S**2*CS**2)-K*XFPHLD-(EPSITH+EPSIPH)*(X1*XFPHL1+X2*
     2            XFPHL2)+YPRED(I+7)*(X1*XFZEL1+X2*XFZEL2)
      YDØT(I+2) = -YPRED(I+2)/S-YANTH*TAN/S+XNSQ*YAMTH/(S**2*CS**2)
     1            -2.0*XN*YAMPT/(S**2*CS)+K*(XN*XMPHLD*X1CS/S-XFZELD)
     2            -(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-YPRED(I+7)*
     3            (X1*XFPHL1+X2*XFPHL2)-X1CS/S*XN*(YANPT*(X1*SAVY(3)+
     4            X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))
      YDØT(I+3)= YAMTH/S-YPRED(I+3)/S-2.0*XN*YAMPT/(S*CS)+YAJPH+XMTHLD
     1            *K
      YDØT(I+6)=YPRED(I+7)
      YDØT(I+7)=(1.0/(XD22-XNUTP**2*XD11))*(-YPRED(I+3)+XNUTP*YAMTH-
     1            K*(XMTPH-XNUTP*XMTTH))
      GØ TØ 9005
C     EQUATIØNS FØR CYLINDER
  153 YANTH=XNUPT*YPRED(I+1)+(XK11-XNUPT**2*XK22)*(X1RØ*(XN*YPRED(I+4)-
     1            YPRED(I+6)))+K*(XNUPT*XNTPH-XNTTH)
      YAMTH=XNUPT*YPRED(I+3)-(X1RØ*(XD11-XNUPT**2*XD22))*(X1RØ*(XN*YPRED
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```
1              (I+4)-XNSQ*YPRED(I+6)))+K*(XNUPT*XMTPH-XMTTH)
  YAØPH      = X1RØ*(XN*YPRED(I+6)-YPRED(I+4))
  YAMPT=(-1.0/((RØ/XD33)+(X1RØ/XK33)))*(-2.0*XN*YPRED(I+7)+XN*X1RØ*
1              YPRED(I+5)+YPRED(I)/XK33+YAØPH*(X1*SAVY(3)+X2*
2              SAVY(6)))
  YAJPH      = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
1              -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
  YANPT      = YPRED(I)+YAMPT*X1RØ
  YDØT(I+4)=XN*YPRED(I+5)*X1RØ+YPRED(I)/XK33+YAMPT*X1RØ/XK33
1              +YAØPH*(X1*SAVY(3)+X2*SAVY(6))
  YDØT(I)    = XN*YANTH*X1RØ-XN*YAMTH*X1RØSQ-K*(XFTHLD+XMPHLD*X1RØ)
1              -(YDØT(I+4)*(X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+
2              X2*XFZEL2))-X1RØ*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*
3              (X1*SAVY(3)+X2*SAVY(6)))
  YDØT(I+5)  = (1.0/(XK22-XNUTP**2*XK11))*(YPRED(I+1)-XNUTP*YANTH+
1              K*(XNTPH-XNUTP*XNTTH))-YPRED(I+7)*(X1*SAVY(3)+X2*
2              SAVY(6))
  EPSITH     = X1RØ*(XN*YPRED(I+4)-YPRED(I+6))
  EPSIPH     = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
  YDØT(I+1)  = -XN*X1RØ*YPRED(I)-XN*YAMPT*X1RØSQ-K*XFPHLD-(EPSITH+
1              EPSIPH)*(X1*XFPHL1+X2*XFPHL2)+YPRED(I+7)*(X1*XFZEL1+
2              X2*XFZEL2)
  YDØT(I+2)  = -YANTH*X1RØ+XNSQ*YAMTH*X1RØSQ+K*(XN*XMPHLD*X1RØ-
1              XFZELD)-(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-
2              YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2)-X1RØ*XN*(YANPT*
3              (X1*SAVY(3)+X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))
  YDØT(I+3)  = -2.0*XN*YAMPT*X1RØ+YAJPH+K*XMTHLD
  YDØT(I+6)=YPRED(I+7)
  YDØT(I+7)  = (1.0/(XD22-XNUTP**2*XD11))*(-YPRED(I+3)+XNUTP*YAMTH+
1              K*(XNUTP*XMTTH-XMTPH))
  GØ TØ 9005
7786 GØ TØ (4771,4772,4773),IGEØM
C     THE FØLLØWING EQUATIØNS ARE THE -ST10- SET
C   EQUATIØNS FØR SHELLS ØF REVØLUTIØN  ( PHI  CØØRDINATE )
4771 YANTH   = XK12*(1.0/(XK22+XC22**2/XD22))*(YPRED(I+1)+K*XNTPH+
1              (XC22/XD22)*(YPRED(I+3)+K*XMTPH))-K*XNTTH+(X1RØ*XK11-
1              XK12*XK21*X1RØ*(1.0/
2        (XK22+XC22**2/XD22)))*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+
3      6)*SN)-(XC11+XK12*XC22*XD21/XD22*(1.0/(XK22+XC22**2/XD22)))*
4       (X1RØ**2*(XN*YPRED(I+4)*SN-XN**2*YPRED(I+6))+YPRED(I+7)*CS*
5        X1RØ)
  YAMTH      = -XD12*(XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH)
1              -K*XMTTH+XD12*(XK22/(XC22**2+XK22*XD22))*(YPRED(I+3)+
1              K*XMTPH)+(XC11*
2         X1RØ+XD12*XK21*X1RØ*(XC22/(XC22**2+XK22*XD22)))*(XN*YPRED(
3        I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)+(XD11-XD12*XK22*XD21/(
4        XC22**2+XK22*XD22))*(X1RØSQ*(XN*YPRED(I+4)*SN-XNSQ*YPRED
5         (I+6))+YPRED(I+7)*CS*X1RØ)
  YAØPH      = XN*YPRED(I+6)*X1RØ-YPRED(I+4)*SN1RØ
  YAMPT      = (-1.0/((RØ/XD33)+(SNSQ*X1RØ/XK33)))*(-2.0*XN*
1              YPRED(I+7)+YPRED(I+4)*(CS1R1-CN1RØ)+XN*YPRED(I+5)*
2              (SN1RØ+X1R1)+2.0*XN*YPRED(I+6)*CS1RØ+YPRED(I)*SN/
3              XK33+SN*YAØPH*(X1*SAVY(3)+X2*SAVY(6)))
  YAJPH      = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
1              -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
  YANPT      = YPRED(I)+YAMPT*SN1RØ
  YDØT(I+4)  = R1*(YPRED(I+4)*CS1RØ+XN*YPRED(I+5)*X1RØ+YPRED(I)/XK33+
1              YAMPT*SN1RØ/XK33)+R1*YAØPH*(X1*SAVY(3)+X2*SAVY(6))
  YDØT(I)    = R1*(-2.0*YPRED(I)*CS1RØ+XN*YANTH*X1RØ-XN*YAMTH*SN*
1              X1RØSQ-YAMPT*CS1RØ*(X1R1-SN1RØ))-R1*K*(XFTHLD+XMPHLD*
2              SN1RØ)-(YDØT(I+4)*(X1*XFPHL1+X2*XFPHL2)+R1*YAØPH*
```

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     3            (X1*XFZEL1+X2*XFZEL2))-R1*SN1RØ*(YAØPH*(X1*SAVY(1)+
     4            X2*SAVY(4))-YANPT*(X1*SAVY(3)+X2*SAVY(6)))
      YDØT(I+5) = R1*(YPRED(I+6)*X1R1-YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
     1            +(1.0/(XK22+XC22**2/XD22))*(YPRED(I+1)+K*XNTPH+(XC22/
     1            XD22)*(YPRED(I+3)+K*XMTPH)-XK21*X1RØ*(XN*
     2           YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)-(XC22*XD21/XD22
     3           )*(X1RØSQ*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+YPRED(I+7)
     4           *CS*X1RØ)))
      EPSITH    = X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)
      EPSIPH    = X1R1*(YDØT(I+5)-YPRED(I+6))+YPRED(I+7)*(X1*SAVY(3)+
     1            X2*SAVY(6))
      YDØT(I+1) = R1*(CS1RØ*(YANTH-YPRED(I+1))-XN*X1RØ*(YPRED(I)+
     1            YAMPT*(SN*X1RØ+X1R1))+YPRED(I+2)*X1R1)-R1*K*XFPHLD
     2            -R1*((EPSITH+EPSIPH)*(X1*XFPHL1+X2*XFPHL2)-YPRED(I+7)*
     3            (X1*XFZEL1+X2*XFZEL2))
      YDØT(I+2) = R1*(-YPRED(I+2)*CS1RØ-YANTH*SN1RØ-YPRED(I+1)*X1R1
     1            +XNSQ*YAMTH*X1RØSQ-2.0*XN*YAMPT*CS*X1RØSQ)+R1*K*
     2            (XN*XMPHLD*X1RØ-XFZELD)-R1*((EPSITH+EPSIPH)*(X1*
     3            XFZEL1+X2*XFZEL2)+YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2))
     4            -R1*X1RØ*XN*(YANPT*(X1*SAVY(3)+X2*SAVY(6))-YAØPH*
     5            (X1*SAVY(1)+X2*SAVY(4)))
      YDØT(I+3) = R1*(YAMTH*CS1RØ-YPRED(I+3)*CS1RØ-2.0*XN*YAMPT*X1RØ+
     1            YAJPH+K*XMTHLD)
      YDØT(I+6) = R1*(YPRED(I+7)-YPRED(I+5)*X1R1)
      YDØT(I+7) = R1*((-XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH-
     1            (XK21/
     1           RØ)*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN))
     2           +(XK22/(XC22**2+XK22*XD22))*(YPRED(I+3)+K*XMTPH)-(XK22*
     3           XD21/(XC22**2+XK22*XD22))*(X1RØSQ*(XN*YPRED(I+4)*SN-XNSQ
     4           *YPRED(I+6))+YPRED(I+7)*CS*X1RØ))
      GØ TØ 9005
C     EQUATIØNS FØR CØNE
 4772 YANTH     = XK12*(1.0/(XK22+XC22**2/XD22))*(YPRED(I+1)+K*XNTPH+
     1            (XC22/XD22)*(YPRED(I+3)+K*XMTPH))-K*XNTTH+(1.0/(CS*S))
     1            *(XK11-XK12*XK21*(
     2       1.0/(XK22+XC22**2/XD22)))*(XN*YPRED(I+4)+YPRED(I+5)*CS-
     3       YPRED(I+6)*SN)-(XC11+(XK12*XD21*XC22/XD22)*(1.0/(XK22+XC22*
     4       *2/XD22)))*((1.0/(S**2*CS**2))*(XN*YPRED(I+4)*SN-XNSQ*YPRED
     5       (I+6))+YPRED(I+7)/S)
      YAMTH     = -XD12*(XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH)
     1            -K*XMTTH+XD12*(XK22/(XC22**2+XK22*XD22))*(YPRED(I+3)+
     1            K*XMTPH)+(XC11/
     2         (S*CS)+XD12*XK21/(S*CS))*(XC22/(XC22**2+XK22*XD22))*(XN*
     3         YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)+(XD11-XD12*XK22*
     4         XD21/(XC22**2+XK22*XD22))*((1.0/(S*CS)**2)*(XN*YPRED(I+4)*
     5         SN-XNSQ*YPRED(I+6))+YPRED(I+7)/S)
      YAØPH     = XN*YPRED(I+6)*X1CS/S-YPRED(I+4)*TAN/S
      YAMPT=(-1.0/((S*CS/XD33)+(SN*TN/(XK33*S))))*(-2.0*XN*YPRED(I+7)-
     1      YPRED(I+4)*SN/S+XN*YPRED(I+5)*TN/S+2.0*XN*YPRED(I+6)/S+YPRED
     2            (I)*SN/XK33+SN*YAØPH*(X1*SAVY(3)+X2*SAVY(6)))
      YAJPH     = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
     1            -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT     = YPRED(I)+YAMPT*TAN/S
      YDØT(I+4)=(1.0/S)*(YPRED(I+4)+XN*YPRED(I+5)*X1CS+YAMPT*TN/XK33)
     1            +YPRED(I)/XK33+YAØPH*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I)  =-2.0*YPRED(I)/S+XN*YANTH*X1CS/S-XN*YAMTH*SN*X1CS**2/S**2
     1            +YAMPT*TAN/S**2-K*(XFTHLD+XMPHLD*TAN/S)-(YDØT(I+4)*
     2            (X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+X2*XFZEL2))-
     3            TAN/S*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*(X1*SAVY(3)
     4            +X2*SAVY(6)))
      YDØT(I+5) = -YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))+(1.0/(XK22+XC22**2
```

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     1            /XD22))*(YPRED(I+1)+K*XNTPH+(XC22/XD22)*(YPRED(I+3)
     1             +K*XMTPH)-(XK21/(S*CS))*(XN*YPRED(I+4)+YPRED(
     2           I+5)*CS-YPRED(I+6)*SN)-(XC22*XD21/XD22)*((1.0/(S**2*CS**
     3           2))*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+YPRED(I+7)/S))
      EPSITH    = (1.0/(S*CS))*(XN*YPRED(I+4)+CS*YPRED(I+5)-SN*
     1             YPRED(I+6))
      EPSIPH    = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I+1)= -YPRED(I+1)/S+YANTH/S-XN*YPRED(I)/(S*CS)-XN*YAMPT*SN/
     1             (S**2*CS**2)-K*XFPHLD-(EPSITH+EPSIPH)*(X1*XFPHL1+X2*
     2             XFPHL2)+YPRED(I+7)*(X1*XFZEL1+X2*XFZEL2)
      YDØT(I+2) = -YPRED(I+2)/S-YANTH*TAN/S+XNSQ*YAMTH/(S**2*CS**2)
     1             -2.0*XN*YAMPT/(S**2*CS)+K*(XN*XMPHLD*X1CS/S-XFZELD)
     2             -(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-YPRED(I+7)*
     3             (X1*XFPHL1+X2*XFPHL2)-X1CS/S*XN*(YANPT*(X1*SAVY(3)+
     4             X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))
      YDØT(I+3)= YAMTH/S-YPRED(I+3)/S-2.0*XN*YAMPT/(S*CS)+YAJPH+XMTHLD
     1             *K
      YDØT(I+6)=YPRED(I+7)
      YDØT(I+7) = -(XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH-XK21*
     1             (XN*
     1           YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)/(S*CS))
     2            +(XK22/(XC22**2+XK22*XD22))*(YPRED(I+3)+K*XMTPH)-(XK22*
     1           XD21
     3           /(XC22**2+XK22*XD22))*((1.0/(S*CS)**2)*(XN*YPRED(I+4)*SN
     4           -XN**2*YPRED(I+6))+YPRED(I+7)/S)
      GØ TØ 9005
C     EQUATIØNS FØR CYLINDER
 4773 YANTH     = XK12*(1.0/(XK22+XC22**2/XD22))*(YPRED(I+1)+K*XNTPH+
     1             (XC22/XD22)*(YPRED(I+3)+K*XMTPH))-K*XNTTH+(X1RØ*(XK11-
     1             XK12*XK21*(1.0/(
     2        XK22+XC22**2/XD22))))*(XN*YPRED(I+4)-YPRED(I+6))-(XC11+(
     3        XK12*XC22*XD21/XD22)*(1.0/(XK22+XC22**2/XD22)))*(X1RØ**2*(
     4        XN*YPRED(I+4)-XNSQ*YPRED(I+6)))
      YAMTH     = -XD12*(XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH)
     1             -K*XMTTH+XD12*(XK22/(XC22**2+XK22*XD22))*(YPRED(I+3)+
     1             K*XMTPH)+(XC11*
     2         X1RØ+XD12*XK21*X1RØ*(XC22/(XC22**2+XK22*XD22)))*(XN*YPRED
     3         (I+4)-YPRED(I+6))+(XD11-XD12*XK22*XD21/(XC22**2+XK22*XD22)
     4         )*(X1RØSQ*(XN*YPRED(I+4)-XNSQ*YPRED(I+6)))
      YAØPH     = X1RØ*(XN*YPRED(I+6)-YPRED(I+4))
      YAMPT=(-1.0/((RØ/XD33)+(X1RØ/XK33)))*(-2.0*XN*YPRED(I+7)+XN*X1RØ*
     1             YPRED(I+5)+YPRED(I)/XK33+YAØPH*(X1*SAVY(3)+X2*
     2             SAVY(6)))
      YAJPH     = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
     1             -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT     = YPRED(I)+YAMPT*X1RØ
      YDØT(I+4)=XN*YPRED(I+5)*X1RØ+YPRED(I)/XK33+YAMPT*X1RØ/XK33
     1             +YAØPH*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I)   = XN*YANTH*X1RØ-XN*YAMTH*X1RØSQ-K*(XFTHLD+XMPHLD*X1RØ)
     1             -(YDØT(I+4)*(X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+
     2             X2*XFZEL2))-X1RØ*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*
     3             (X1*SAVY(3)+X2*SAVY(6)))
      YDØT(I+5) = -YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))+(1.0/(XK22+XC22**2
     1             /XD22))*(YPRED(I+1)+K*XNTPH+(XC22/XD22)*(YPRED(I+3)
     1             +K*XMTPH)-(XK21*X1RØ)*(XN*YPRED(I+4)-YPRED
     2      (I+6))-(XC22*XD21/XD22)*(X1RØSQ*(XN*(YPRED(I+4)-XN*YPRE
     3             D(I+6)))))
      EPSITH    = X1RØ*(XN*YPRED(I+4)-YPRED(I+6))
      EPSIPH    = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I+1) = -XN*X1RØ*YPRED(I)-XN*YAMPT*X1RØSQ-K*XFPHLD-(EPSITH+
     1             EPSIPH)*(X1*XFPHL1+X2*XFPHL2)+YPRED(I+7)*(X1*XFZEL1+
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2             X2*XFZEL2)
 YDØT(I+2) = -YANTH*X1RØ+XNSQ*YAMTH*X1RØSQ+K*(XN*XMPHLD*X1RØ-
1             XFZELD)-(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-
2             YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2)-X1RØ*XN*(YANPT*
3             (X1*SAVY(3)+X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))
 YDØT(I+3) = -2.0*XN*YAMPT*X1RØ+YAJPH+K*XMTHLD
 YDØT(I+6)=YPRED(I+7)
 YDØT(I+7) = -(XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH-XK21*
1             X1RØ*(
1           XN*YPRED(I+4)-YPRED(I+6)))+(XK22/(XC22**2+XK22*XD22))*(
2             YPRED(I+3)+K*XMTPH)-(XK22*XD21/(XC22**2+XK22*XD22))*(
3           X1RØSQ*(XN*YPRED(I+4)-XNSQ*YPRED(I+6)))
9005 IY =8*(M-1)+1
 YASAVE(IY) = YANTH
 YASAVE(IY+1)=YAMTH
 YASAVE(IY+2)=YAMPT
 YASAVE(IY+3)=YANPT
 YASAVE(IY+4)=YAØPH
 YASAVE(IY+7) = YAJPH
 RETURN
  END
```

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C ..... RØUTINE **D20       ** ABACUS UPDATED 07/07/72 .....             2100000
      SUBRØUTINE ØDE2(XFPHL1,XFZEL1,XFPHL2,XFZEL2)
      INTEGER SAVJTC,SAVSTP,Q,THICK
      INTEGER XN1,XN                                                      2100030
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK                   2100040
      DØUBLE PRECISIØN YPRED                                              2100050
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)          2100060
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)                              2100070
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(2),NH             2100080
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)    2100090
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB   2100100
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE   2100110
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS              2100120
      CØMMØN /LASTEQ/ YPRED(16),YDØT(16),YASAVE(16),                      2100130
     1               YANTH,YAMTH,YAMPT,YANPT,YAØPH,YAQPH,YAQTH,YAJPH,     2100140
     2               S,SN,CS,SNSQ,CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,           2100150
     3               X1RØ,X1RØSQ,X1SNRØ,X1CSRØ,CN1RØ,SN1RØ,CS1RØ,         2100160
     4               X1R1,X1R2,CS1R1,CS1R2,SN1R1,X1R1SQ,R2SQ,RØ,BESQ,     2100170
     5   RØSQ,XNSQ,BETA,R1,R2,S1,R1DØT,R1SQ,                              2100180
     6               XNTTH,XNTPH,XMTTH,XMTPH,XFTHLD,XFPHLD,XFZELD,        2100190
     7 XMTHLD,XMPHLD,ETHET(2),EPHI(2),XGPT(2),ALPHTH(2),ALPHPH(2),        2100200
     8               XNUTP,XNUPT,XC11,XC22,XC15,XD33,XD22,XD21,XD12,      2100210
     9               XK11,XK12,XK21,XK22,XK33,XD11,                       2100220
     A                  M,I,SITIN,SITØUT,SIPIN,SIPØUT,TPTIN,TPTØUT,       2100230
     B             ZBRIN,ZBRØUT,SCRIPA,SCRIPI,SIFIN,SIFØUT,TZEPH,TZETH    2100240
     C               ,XNPHI,BETTA,ZETTA,SAVY(8),XC16                      2100250
      EQUIVALENCE (XNL(1),X1),(XNL(2),X2)                                 2100260
      K = 0                                                               2100270
      IF (KBC.EQ.0.AND.NH.EQ.0) K = 1                                     2100280
      GØ TØ (7341,7342,7343),IGEØM                                        2100340
C     THE FØLLØWING EQUATIØNS ARE THE -RWAF- SET                          2100350
C     EQUATIØNS FØR SHELLS ØF REVØLUTIØN ( PHI CØØRDINATE )               2100360
 7341 YANTH     = (YPRED(I+1)+K*XNTPH)*(XC15*XC22+XD22*XK12)/(XK22*XD22+ 2100370
     1 XC22**2)-K*XNTTH+(XK12*XC22-XK22*XC15)*(YPRED(I+3)+K*XMTPH)/       2100380
     2 (XC22*XC22+XK22*XD22)+X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-           2100390
     3 YPRED(I+6)*SN)*(XK11+(XC15*(XC15*XK22-2.0*XK12*XC22)-XK12*XK12*    2100400
     4 XD22)/(XK22*XD22+XC22*XC22))+(X1RØSQ*(XN*YPRED(I+4)*SN-XNSQ        2100410
     5 *YPRED(I+6))+X1RØ*YPRED(I+7)*CS)*(-XC11+(XC15*XC15*XC22+           2100420
     6 XC15*(XK12*XD22+XK22*XD12)-XK12*XD12*XC22)/(XK22*XD22+XC22*XC22)) 2100430
      YAMTH     = (YPRED(I+3)+K*XMTPH)*(XC15*XC22+XK22*XD12)/(XK22*XD22+ 2100440
     1 XC22*XC22)+(YPRED(I+1)+K*XNTPH)*(XD22*XC15-XD12*XC22)/(XD22*XK22+ 2100450
     2 XC22**2)-K*XMTTH+(X1RØSQ*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+       2100460
     3 X1RØ*YPRED(I+7)*CS)*(XD11-(XD12*XD12*XK22+XC15*(2.0*XC22*XD12-     2100470
     3 XC15*                                                              2100480
     4 XD22))/(XC22*XC22+XK22*XD22))+X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-   2100490
     5 YPRED(I+6)*SN)*(XC11+(XD12*XC22*XK12-XC15*(XC15*XC22+XD12*XK22+    2100500
     6 XD22*XK12))/(XC22*XC22+XK22*XD22))                                 2100510
      YAØPH     = XN*YPRED(I+6)*X1RØ-YPRED(I+4)*SN1RØ                     2100520
      YAMPT = (1.0/(XC16*SN*X1RØ-XK33-SN*X1RØ*(XD33*SN/(      RØ)-XC16))) 2100530
     1         *((XK33*XD33-XC16**2)*X1RØ*(-2.0*XN*YPRED(I+7)+YPRED(I+4)* 2100540
     2         (CS*X1R1-CN1RØ)+XN*YPRED(I+5)*(X1R1+SN1RØ)+2.0*XN*YPRED    2100550
     3         (I+6)*CS*X1RØ)+YAØPH*SN*(X1*SAVY(3)+X2*SAVY(6))+YPRED(I)*  2100560
     4         (XD33*SN*X1RØ-XC16))                                       2100570
      YAJPH     = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))           2100580
     1           -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))                      2100590
      YANPT     = YPRED(I)+YAMPT*SN1RØ                                    2100600
      YDØT(I+4) = R1*(YPRED(I+4)*CS*X1RØ+YAØPH*(X1*SAVY(3)+X2*SAVY(6))   2100610
     1             +XN*YPRED(I+5)*X1RØ+(1.0/(XK33-                        2100620
     1            XC16**2/XD33))*(YPRED(I)+YAMPT*(SN*X1RØ-XC16/XD33)))    2100630
      YDØT(I)   = R1*(-2.0*YPRED(I)*CS1RØ+XN*YANTH*X1RØ-XN*YAMTH*SN*     2100640
```

```
     1            X1RØSQ-YAMPT*CS1RØ*(X1R1-SN1RØ))-R1*K*(XFTHLD+XMPHLD*  2100650
     2            SN1RØ)-(YDØT(I+4)*(X1*XFPHL1+X2*XFPHL2)+R1*YAØPH*      2100660
     3            (X1*XFZEL1+X2*XFZEL2))-R1*SN1RØ*(YAØPH*(X1*SAVY(1)+    2100670
     4            X2*SAVY(4))-YANPT*(X1*SAVY(3)+X2*SAVY(6)))             2100680
      YDØT(I+5) = YPRED(I+6)-R1*YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))+R1*   2100690
     1            (XD22*(YPRED(I+1)+K*XNTPH)+XC22*(YPRED(I+3)+K*XMTPH)-  2100700
     2            X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)*      2100710
     3            (XK12*XD22+XC15*XC22)-(X1RØSQ*(XN*YPRED(I+4)-XNSQ*     2100720
     4            YPRED(I+6))+X1RØ*YPRED(I+7)*CS)*(XC22*XD12-XC15*XD22)) 2100730
     5            /(XK22*XD22+XC22**2)                                   2100740
      EPSITH    = X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)       2100750
      EPSIPH    = X1R1*(YDØT(I+5)-YPRED(I+6))+YPRED(I+7)*(X1*SAVY(3)+    2100760
     1            X2*SAVY(6))                                            2100770
      YDØT(I+1) = R1*(CS1RØ*(YANTH-YPRED(I+1))-XN*X1RØ*(YPRED(I)+        2100780
     1            YAMPT*(SN*X1RØ+X1R1))+YPRED(I+2)*X1R1)-R1*K*XFPHLD     2100790
     2            -R1*((EPSITH+EPSIPH)*(X1*XFPHL1+X2*XFPHL2)-YPRED(I+7)* 2100800
     3            (X1*XFZEL1+X2*XFZEL2))                                 2100810
      YDØT(I+2) = R1*(-YPRED(I+2)*CS1RØ-YANTH*SN1RØ-YPRED(I+1)*X1R1      2100820
     1            +XNSQ*YAMTH*X1RØSQ-2.0*XN*YAMPT*CS*X1RØSQ)+R1*K*       2100830
     2            (XN*XMPHLD*X1RØ-XFZELD)-R1*((EPSITH+EPSIPH)*(X1*       2100840
     3            XFZEL1+X2*XFZEL2)+YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2))    2100850
     4            -R1*X1RØ*XN*(YANPT*(X1*SAVY(3)+X2*SAVY(6))-YAØPH*      2100860
     5            (X1*SAVY(1)+X2*SAVY(4)))                               2100870
      YDØT(I+3) = R1*(YAMTH*CS1RØ-YPRED(I+3)*CS1RØ-2.0*XN*YAMPT*X1RØ+    2100880
     1            YAJPH+K*XMTHLD)                                        2100890
      YDØT(I+6) = R1*(YPRED(I+7)-YPRED(I+5)*X1R1)                        2100900
      YDØT(I+7) = R1*(XK22*(YPRED(I+3)+K*XMTPH)-XC22*(YPRED(I+1)+K*      2100910
     1            XNTPH)+X1RØ                                            2100920
     1*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)*(XK12*XC22-XK22*XC15) 2100930
     2-(X1RØSQ*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+X1RØ*YPRED(I+7)*CS)*   2100940
     3(XC15*XC22+XK22*XD12))/(XC22**2+XK22*XD22)                         2100950
      GØ TØ 9005                                                         2100960
C     EQUATIØNS FØR CØNE                                                 2100970
 7342 YANTH     = (YPRED(I+1)+K*XNTPH)*(XC15*XC22+XD22*XK12)/(XK22*XD22+ 2100980
     1 XC22**2)-K*XNTTH+(XK12*XC22-XK22*XC15)*(YPRED(I+3)+K*XMTPH)/      2100990
     2 (XC22*XC22+XK22*XD22)+(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)     2101000
     3 *SN)/(S*CS)*(XK11+(XC15*(XC15*XK22-2.0*XK12*XC22)-XK12*XK12*      2101010
     4 XD22)/(XK22*XD22+XC22*XC22))+((XN*YPRED(I+4)*SN-XNSQ*             2101020
     5 YPRED(I+6))/(S*S*CSSQ)+YPRED(I+7)/S)*(-XC11+(XC15*XC15*XC22+      2101030
     6 XC15*(XK12*XD22+XK22*XD12)-XK12*XD12*XC22)/(XK22*XD22+XC22*XC22)) 2101040
      YAMTH     = (YPRED(I+3)+K*XMTPH)*(XC15*XC22+XK22*XD12)/(XK22*XD22+ 2101050
     1 XC22**2)+(YPRED(I+1)+K*XNTPH)*(XD22*XC15-XD12*XC22)/(XD22*XK22+   2101060
     2 XC22**2)-K*XMTTH+(1.0/(S*S*CSSQ)*(-XNSQ*YPRED(I+6)+XN*YPRED(I+4)* 2101070
     3 SN)+YPRED(I+7)/S)*(XD11-(XD12*XD12*XK22+XC15*(2.0*XC22*XD12-XC15* 2101080
     4 XD22))/(XC22*XC22+XK22*XD22))+1.0/(S*CS)*(XN*YPRED(I+4)+          2101090
     5 YPRED(I+5)*CS-                                                    2101100
     5 YPRED(I+6)*SN)*(XC11+(XD12*XC22*XK12-XC15*(XC15*XC22+XD12*XK22+   2101110
     6 XD22*XK12))/(XC22*XC22+XK22*XD22))                                2101120
      YAØPH     = XN*YPRED(I+6)*X1CS/S-YPRED(I+4)*TAN/S                  2101130
      YAMPT =((XC16*TAN/S-XK33-(TAN/S)*(XD33*TAN/S-XC16))**(-1))*((XK33* 2101140
     1         XD33-XC16**2)*(1.0/(S*CS))*(-2.0*XN*YPRED(I+7)-YPRED(I+4)* 2101150
     2          SN/S+XN*YPRED(I+5)*TAN/S+2.0*XN*YPRED(I+6)/S)+YAØPH*SN*  2101160
     3          (X1*SAVY(3)+X2*SAVY(6))+YPRED(I)*(XD33*TAN/S-XC16))      2101170
      YAJPH     = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))          2101180
     1            -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))                    2101190
      YANPT     = YPRED(I)+YAMPT*TAN/S                                   2101200
      YDØT(I+4) = YPRED(I+4)/S+YAØPH*(X1*SAVY(3)+X2*SAVY(6))+XN*         2101210
     1            YPRED(I+5)/(S*CS)+(1.0/(XK33-XC16**2/                  2101220
     1             XD33))*(YPRED(I)+YAMPT*(TAN/S-XC16/XD33))             2101230
      YDØT(I)   =-2.0*YPRED(I)/S+XN*YANTH*X1CS/S-XN*YAMTH*SN*X1CS**2/S**2 2101240
     1            +YAMPT*TAN/S**2-K*(XFTHLD+XMPHLD*TAN/S)-(YDØT(I+4)*    2101250
```

```
     2          (X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+X2*XFZEL2))-
     3          TAN/S*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*(X1*SAVY(3)
     4          +X2*SAVY(6)))
      YDØT(I+5) = -YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))+(XD22*(YPRED(I+1)
     1          +K*XNTPH)+XC22*(YPRED(I+3)+K*XMTPH)-(XK12*
     1         XD22+XC15*XC22)*(1.0/(S*CS)*(XN*YPRED(I+4)+YPRED(I+5)*
     2         CS-YPRED(I+6)*SN))-(XC22*XD12-XC15*XD22)*((-XNSQ*
     3         YPRED(I+6)+XN*YPRED(I+4)*SN)/(S*S*CSSQ)+YPRED(I+7)/S))
     4         /(XK22*XD22+XC22*XC22)
      EPSITH    = (1.0/(S*CS))*(XN*YPRED(I+4)+CS*YPRED(I+5)-SN*
     1          YPRED(I+6))
      EPSIPH    = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I+1)= -YPRED(I+1)/S+YANTH/S-XN*YPRED(I)/(S*CS)-XN*YAMPT*SN/
     1          (S**2*CS**2)-K*XFPHLD-(EPSITH+EPSIPH)*(X1*XFPHL1+X2*
     2          XFPHL2)+YPRED(I+7)*(X1*XFZEL1+X2*XFZEL2)
      YDØT(I+2) = -YPRED(I+2)/S-YANTH*TAN/S+XNSQ*YAMTH/(S**2*CS**2)
     1          -2.0*XN*YAMPT/(S**2*CS)+K*(XN*XMPHLD*X1CS/S-XFZELD)
     2          -(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-YPRED(I+7)*
     3          (X1*XFPHL1+X2*XFPHL2)-X1CS/S*XN*(YANPT*(X1*SAVY(3)+
     4          X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))
      YDØT(I+3)= YAMTH/S-YPRED(I+3)/S-2.0*XN*YAMPT/(S*CS)+YAJPH+XMTHLD
     1          *K
      YDØT(I+6)=YPRED(I+7)
      YDØT(I+7) = (XK22*(YPRED(I+3)+K*XMTPH)-XC22*(YPRED(I+1)+K*XNTPH)+
     1         (XK12*XC22-XK22*XC15)*(1.0/(S*CS)*(XN*YPRED(I+4)+
     2         YPRED(I+5)*CS-YPRED(I+6)*SN))-(XC15*XC22+XK22*XD12)*
     3         ((-XNSQ*YPRED(I+6)+XN*YPRED(I+4)*SN)/(S*S*CSSQ)+
     4         YPRED(I+7)/S))/(XK22*XD22+XC22*XC22)
      GØ TØ 9005
C     EQUATIØNS FØR CYLINDER
 7343 YANTH     = (YPRED(I+1)+K*XNTPH)*(XC15*XC22+XD22*XK12)/(XK22*XD22+
     1 XC22**2)-K*XNTTH+(XK12*XC22-XK22*XC15)*(YPRED(I+3)+K*XMTPH)/
     2 (XC22*XC22+XK22*XD22)+X1RØ*(XN*YPRED(I+4)-
     3 YPRED(I+6))*(XK11+(XC15*(XC15*XK22-2.0*XK12*XC22)-XK12*XK12*
     4 XD22)/(XK22*XD22+XC22*XC22))+(X1RØSQ*(XN*YPRED(I+4)-XNSQ
     5 *YPRED(I+6)))*(-XC11+(XC15*XC15*XC22+
     6 XC15*(XK12*XD22+XK22*XD12)-XK12*XD12*XC22)/(XK22*XD22+XC22*XC22))
      YAMTH     = (YPRED(I+3)+K*XMTPH)*(XC15*XC22+XK22*XD12)/(XK22*XD22+
     1 XC22**2)+(YPRED(I+1)+K*XNTPH)*(XD22*XC15-XD12*XC22)/(XD22*XK22+
     2 XC22**2)-K*XMTTH+X1RØSQ*(XN*YPRED(I+4)-XNSQ*YPRED(I+6))
     3 *(XD11-(XD12*XD12*XK22+XC15*(2.0*XC22*XD12-XC15*
     4 XD22))/(XC22*XC22+XK22*XD22))+X1RØ*(XN*YPRED(I+4)-
     5 YPRED(I+6))*(XC11+(XD12*XC22*XK12-XC15*(XC15*XC22+XD12*XK22+
     6 XD22*XK12))/(XC22*XC22+XK22*XD22))
      YAØPH     = X1RØ*(XN*YPRED(I+6)-YPRED(I+4))
      YAMPT=(1/(XC16*X1RØ-XK33-X1RØ*(XD33*X1RØ-XC16)))*((XK33*XD33-XC16
     1        **2)*X1RØ*(-2.0*XN*YPRED(I+7)+XN*X1RØ*YPRED(I+5))+YAØPH*
     2        (X1*SAVY(3)+X2*SAVY(6))+YPRED(I)*(XD33*X1RØ-XC16))
      YAJPH     = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
     1          -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT     = YPRED(I)+YAMPT*X1RØ
      YDØT(I+4) = (YAØPH*(X1*SAVY(3)+X2*SAVY(6))+XN*YPRED(I+5)/RØ)+
     1          (1.0/(XK33-XC16**2/XD33))*(YPRED(I)+
     1         YAMPT*(X1RØ-XC16/XD33))
      YDØT(I)   = XN*YANTH*X1RØ-XN*YAMTH*X1RØSQ-K*(XFTHLD+XMPHLD*X1RØ)
     1          -(YDØT(I+4)*(X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+
     2          X2*XFZEL2))-X1RØ*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*
     3          (X1*SAVY(3)+X2*SAVY(6)))
      YDØT(I+5) = -YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))+(XD22*(YPRED(I+1)
     1          +K*XNTPH)+XC22*(YPRED(I+3)+K*XMTPH)-X1RØ*
     1(XN*YPRED(I+4)-YPRED(I+6))*(XK12*XD22+XC15*XC22)-X1RØSQ*(XN*YPRED
```

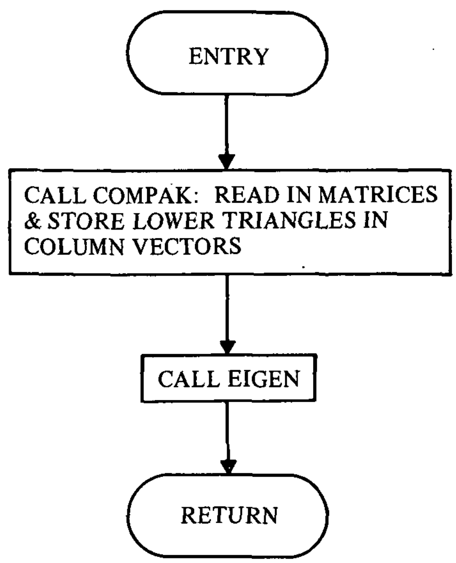
```
     2(I+4)-XNSQ*YPRED(I+6))*(XC22*XD12-XC15*XD22))/(XK22*XD22+XC22**2)
      EPSITH    = X1RØ*(XN*YPRED(I+4)-YPRED(I+6))
      EPSIPH    = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I+1) = -XN*X1RØ*YPRED(I)-XN*YAMPT*X1RØSQ-K*XFPHLD-(EPSITH+
     1            EPSIPH)*(X1*XFPHL1+X2*XFPHL2)+YPRED(I+7)*(X1*XFZEL1+
     2            X2*XFZEL2)
      YDØT(I+2) = -YANTH*X1RØ+XNSQ*YAMTH*X1RØSQ+K*(XN*XMPHLD*X1RØ-
     1            XFZELD)-(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-
     2            YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2)-X1RØ*XN*(YANPT*
     3            (X1*SAVY(3)+X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))
      YDØT(I+3) = -2.0*XN*YAMPT*X1RØ+YAJPH+K*XMTHLD
      YDØT(I+6)=YPRED(I+7)
      YDØT(I+7) = (XK22*(YPRED(I+3)+K*XMTPH)-XC22*(YPRED(I+1)+K*XNTPH)
     1           +X1RØ*
     1(XN*YPRED(I+4)-YPRED(I+6))*(XK12*XC22-XK22*XC15)-X1RØSQ*(XN*YPRED
     2(I+4)-XNSQ*YPRED(I+6))*(XC15*XC22+XK22*XD12))/(XC22**2+XK22*XD22)
 9005 IY =8*(M-1)+1
      YASAVE(IY) = YANTH
      YASAVE(IY+1)=YAMTH
      YASAVE(IY+2)=YAMPT
      YASAVE(IY+3)=YANPT
      YASAVE(IY+4)=YAØPH
      YASAVE(IY+7) = YAJPH
      RETURN
       END
```

SUBROUTINE EIGVAL

This is the controlling routine for the program eigenvalue calculation loop. The necessary matrices for the calculations are passed to COMPAK, and thence to routine EIGEN. The controlling routine EIGVAL will provide intermediate matrix print as desired.

Subroutine COMPAK: This routine reads rows of a two-dimensional array from a storage unit into core and then stores them into a column vector.

EIGVAL


ENTRY
CALL COMPAK: READ IN MATRICES & STORE LOWER TRIANGLES IN COLUMN VECTORS
CALL EIGEN
RETURN

```
C ..... RØUTINE ** EIGVAL ** ABACUS UPDATED 07/24/72 .....            3400000
      SUBRØUTINE EIGVAL (CØNV,EIG,N,IBEGIN,QVEC)                      3400010
      DIMENSIØN A(8400),B(8300),Q(1024),QVEC(128,1)
      REWIND 4                                                        3400030
      REWIND 11                                                       3400031
      CALL CØMPAK (4,N,A)                                             3400040
      CALL CØMPAK (11,N,B)                                            3400050
      INDEX = (N*N+N)/2                                               3400060
      IF (IBEGIN.EQ.0) GØ TØ 50                                       3400070
      M = 1                                                           3400080
      WRITE(6,21)                                                     3400090
   21 FØRMAT(1H1,- LIVE LØAD PRESTRESS STIFFNESS MATRIX-)
      DØ 20 J=1,N                                                     3400110
      K = M+J-1                                                       3400120
      WRITE(6,22) J,(A(I),I=M,K)                                      3400130
   22 FØRMAT(I5,1P8E15.6/(5X,1P8E15.6))                               3400140
   20 M = K+1                                                         3400150
      M = 1                                                           3400160
      WRITE(6,31)                                                     3400170
   31 FØRMAT(1H1,- DEAD LØAD PRESTRESS ØR BASE STIFFNESS MATRIX-)
      DØ 30 J=1,N                                                     3400190
      K = M+J-1                                                       3400200
      WRITE(6,22) J,(B(I),I=M,K)                                      3400210
   30 M = K+1                                                         3400220
   50 CØNTINUE                                                        3400230
      DØ 10 J=1,INDEX                                                 3400240
   10 A(J) = -(A(J)-B(J))                                             3400250
      CALL EIGEN(N,A,B,CØNV,Q,EIG,QVEC)
      RETURN                                                          3400290
      END                                                             3400300
```

```
C ..... RØUTINE ** CØMPAK ** ABACUS UPDATED 05/20/72 .....
      SUBRØUTINE CØMPAK (NTAPE,IRØW,C)
      DIMENSIØN C(1),X(128)
      M = 1
      DØ 10 J=1,IRØW
      READ(NTAPE) (X(I),I=1,IRØW)
      DØ 20 L=1,J
      C(M) = X(L)
   20 M = M+1
   10 CØNTINUE
      RETURN
      END
```

SUBROUTINE EIGEN

EIGEN is the main eigenvalue and eigenvector calculation routine. Printout of the eigenvalues and appropriate eigenvectors is provided by this routine. First EIGEN prepares the matrices for eigenvalue extraction, calling FUTILE, DAGGER, and SWITCH. Then the matrices are passed to SYMEIG, which obtains the eigenvalues and specified vectors using the Householder technique.

Subroutine DAGGER: This routine performs the reduction of the two matrix eigenvalue problem to a standard eigenvalue problem.

Subroutine SYMEIG (Alternate entry point SYMVEC): This routine obtains the eigenvalues and vectors of a real, symmetric, matrix.

Subroutine TFORM: This routine performs the Householder similarity reduction of a real, symmetric matrix to tri-diagonal form.

Subroutine STURM: Performs the Sturm-sequence calculations of eigenvalues of a real, symmetric, tri-diagonal matrix.

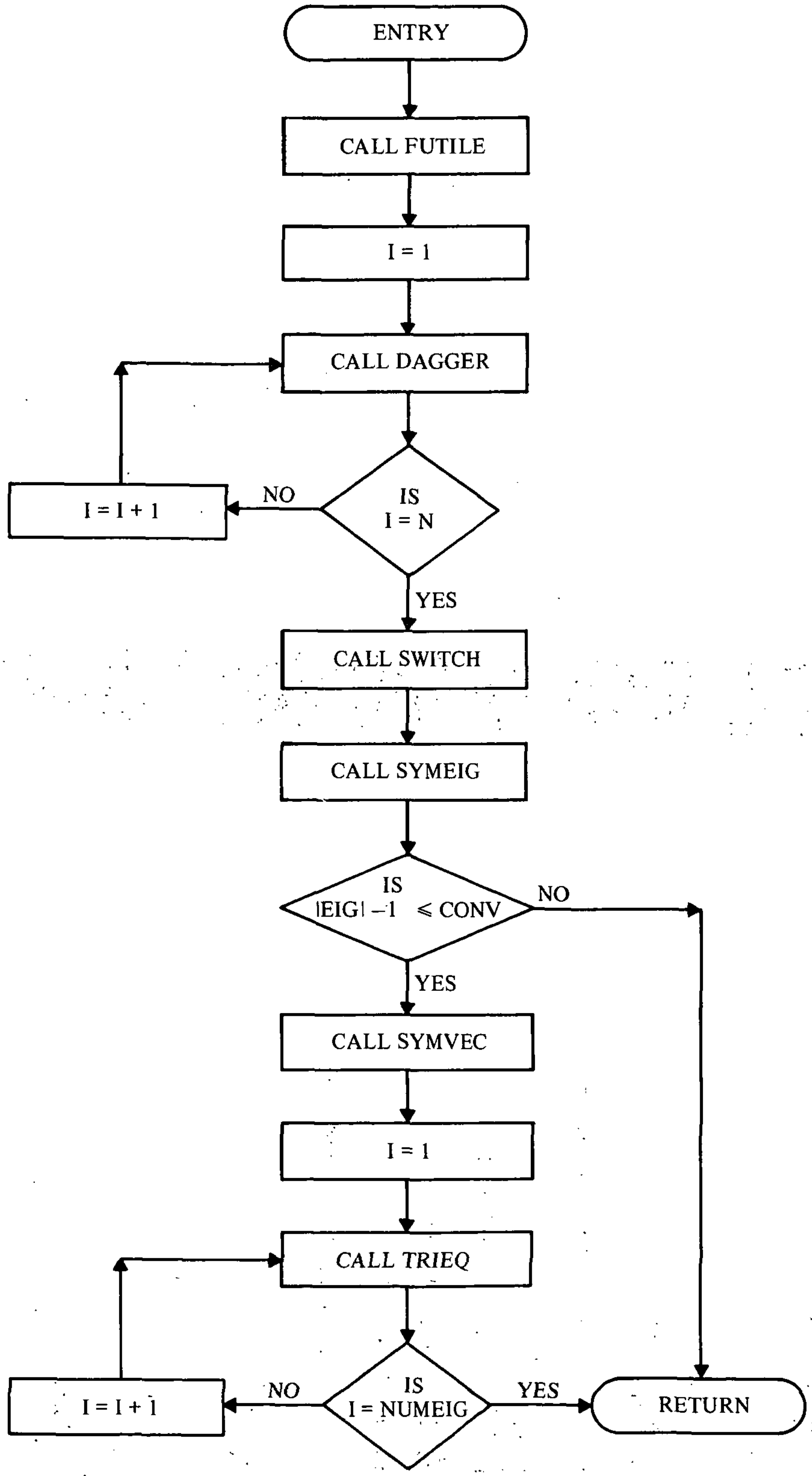
Subroutine PREP (alternate entry point DET): Determines the number of roots greater or equal to a stipulated value.

Subroutine QSVEC (alternate entry point QWIEL): Obtains eigenvectors of a tri-diagonal matrix and back transforms them to eigenvectors of the original real, symmetric matrix.

Subroutine RANDOM: Random number generator. This subroutine is an MSFC system subroutine and the listing is not included here. Most any random number generator may be substituted or the argument may be set to zero.

Subroutine ANDD: This routine "ands" or "ors" the corresponding bits of two given variables with each other.

Subroutine DOTPRO: Performs inner product accumulation using labeled common area INFO.


ENTRY
CALL FUTILE
I = 1
CALL DAGGER
IS
I = N
NO
I = I + 1
YES
CALL SWITCH
CALL SYMEIG
IS
|EIG| –1 ⩽ CONV
NO
YES
CALL SYMVEC
I = 1
CALL TRIEQ
IS
I = NUMEIG
NO
I = I + 1
YES
RETURN

```
C ..... RØUTINE ** EIGEN   ** ABACUS UPDATED 07/19/72 .....
      SUBRØUTINE EIGEN(N,A,B,CØNV,Q,EIG,QVEC)
C  SØLVE THE EIGENVALUE PRØBLEM
C
C          (A)(X)=(LAMBDA)(B)(X)
C
      DIMENSIØN A(1),Q(1),B(1)
      DIMENSIØN C(128),QVEC(128,1)
      CØMMØN /WINTER/INDIC8
      CØMMØN /BØND/M,L
      REWIND 4
      INDIC8=-1
      M=N
      L=1
      TØL = 0.1E-7
      NUMEIG = N
      INDEX=(N*N+N)/2+1
      INDEX1=INDEX-1
      NIX = 0
C
C    FØRM CHØLESKY DECØMPØSITIØN ØF B MATRIX
C
      CALL FUTILE (B,N,NIX)
      IF(NIX)2,3,4
    2 WRITE(6,41)
   41 FØRMAT(- B IS NØT PØSITIVE DEFINITE-)
      RETURN
    4 WRITE(6,42)
   42 FØRMAT(- ØVERFLØW IN FUTILE-)
C
C      L-MATRIX STØRED IN B
C
C
C    FØRM A-MATRIX CØLUMN INVERSES - STØRE IN Q
C
    3 IØFF=1
      DØ 10 I=1,N
      J2 = IØFF+I-1
      K = 1
      DØ 1 J=IØFF,J2
      Q(K) = B(J)
    1 K = K+1
      WRITE(4) (Q(J),J=1,I)
      IØFF = IØFF+I
      X=-Q(I)
      Q(I)=-1.
      DØ 20 J=1,I
   20 Q(J)=Q(J)/X
   10 CALL DAGGER(A,N,Q,I,A(INDEX))
C
C    STØRE (L)(A)(L-TRANSPØSE) IN A FØRM SUITABLE FØR SYMEIG
C       WHERE L IS THE INVERSE ØF THE CHØLESKY MATRIX
C
      CALL SWITCH(A,N)
      CALL SYMEIG(A,N,1,NUMEIG,Q,TØL)
      DØ 300 I=1,NUMEIG
  300 C(I) = 1.0/Q(I)
      WRITE(6,56) (C(I),I=1,NUMEIG)
   56 FØRMAT(////- EIGENVALUES-/(1P8E15.6))
C
```

```
C     EIGENVALUES ARE IN Q                                              3600610
C                                                                       3600620
      EIG = C(1)                                                        3600630
      IF (ABS(ABS(EIG)-1.0).GT.CØNV) GØ TØ 99                           3600640
      NUMEIG=2
      DØ 30 I=1,NUMEIG
      CALL SYMVEC (A(INDEX),I,1,N)
      IN=INDEX1+N                                                       3600670
      WRITE(4)(A(IND),IND=INDEX,IN)
   30 CØNTINUE
      REWIND 4
      IØFF=1                                                            3600720
      DØ 40 I=1,N                                                       3600730
      J2=IØFF+I-1                                                       3600740
      READ(4) (A(J),J=IØFF,J2)                                          3600750
   40 IØFF=IØFF+I                                                       3600760
      DØ 50 I=1,NUMEIG                                                  3600780
      READ(4)(Q(J),J=1,N)
      CALL TRIEQ (A,Q)                                                  3600790
      WRITE(6,57)I,(Q(IJ),IJ=1,N)                                       3600800
   57 FØRMAT(//- EIGENVECTØR-,I4/(1P8E15.6))                            3600810
      DØ 70 IJ=1,N
   70 QVEC(IJ,I)=Q(IJ)
   50 CØNTINUE                                                          3600820
   99 RETURN                                                            3600830
      END                                                               3600840
```

```
C ..... RØUTINE ** DAGGER ** ABACUS UPDATED 07/19/72 .....
      SUBRØUTINE DAGGER(A,M,P,KO,Q)
      DIMENSIØN A(1),P(1),Q(1)
      EQUIVALENCE (SUN,SUM)
      K = KO
      K1 = K + 1
      L=1
      LL = 0
      INDEX = 1
      DØ 130  I = 2,K1
      LJ = INDEX
      SUM = 0.
      DØ 90  J = 1,L
      SUM = SUM + A(LJ)*P(J)
   90 LJ = LJ + 1
      IF (K - L) 100,120,100
  100 LL = LL + L
      LJ = LL + L
      DØ 110  J = I,K
      SUM = SUM + A(LJ)*P(J)
  110 LJ = LJ + J
  120 Q(I-1) = SUN
      INDEX = INDEX + L
  130 L = I
      SUM = 0.
      DØ 140  I = 1,K
      SUM = SUM + P(I)*Q(I)
      A(LL+1) = Q(I)
  140 LL = LL + 1
      A(LL) = SUN
      IF (M - K)  150, 200, 150
  150 DØ 190  L = K1,M
      JL = LL+L-K
      SUM = 0.
      DØ 180  J = 1,K
      SUM = SUM + P(J)*A(JL)
  180 JL = JL + 1
      LL = LL + L - 1
  190 A(LL) = SUM
  200 CØNTINUE
      RETURN
      END
```

```
C ..... RØUTINE ** SYMEIG ** ABACUS UPDATED 05/20/72 .....
      SUBRØUTINE SYMEIG(A,M,INDEX,NUMBR,R,TØL)
C  MASTER RØUTINE FØR EIGENVALUES AND (ØPTIØNALLY) EIGENVECTØRS ØF A
C    REAL SYMMETRIC MATRIX STØRED TRIANGULARLY IN CØRE. THE HØUSEHØLDER
C    REDUCTIØN TØ TRIDIAGØNAL FØRM (SUBRØUTINE TFØRM) IS FØLLØWED BY A
C    BISECTIØN TECHNIQUE (SUBRØUTINE STURM) FØR THE RØØTS AND THEN IN-
C    VERSE ITERATIØN (SUBRØUTINE TRIVEC) FØR THE VECTØRS.
C
C
C  MEANING ØF THE PARAMETERS.
C    A         -  THE TRIANGULAR ARRAY CØNTAINING THE MATRIX. DURING EXEC-
C                   CUTIØN THE ARRAY IS CHANGED.
C
C    M         -  ØRDER ØF A.
C
C    INDEX     -  INDEX ØF FIRST EIGENVALUE REQUIRED.
C
C    NUMBR     - NUMBER ØF EIGENVALUES REQUIRED.
C
C    R         - REAL ARRAY FØR THE RØØTS AND WØRKING STØRAGE. R MUST CØN-
C                  TAIN AT LEAST 8*M WØRDS AND START ØN A D.P. BØUNDARY.
C
C    TØL       - TØLERANCE. IF B IS THE MAG. ØF LARGEST RØØT, THE RØØTS
C                  WILL USUALLY HAVE ERRØRS AS LARGE AS B*TØL.
C
      DIMENSIØN A(1),R(1)
      LD = 1 + M
      LØ = LD + M
      LS = LØ + M
      LP = LS + M
      LQ = LP + M
      LR = LQ + M
      CALL TFØRM(A,M,R(LD),R(LØ),R(LS),R(LP))
      EPS = AMIN1(TØL,1.E-3)
      CALL STURM(M,INDEX,NUMBR,R(LD),R(LØ),R(LS),R(LP),R,EPS)
      RETURN
      ENTRY SYMVEC(X,LØW,KØUNT,MID)
      DIMENSIØN X(MID,1)
      CALL  QSVEC(A,R(LD),R(LØ),R(LP),R(LQ),R(LR),R(LS),M)
      RØØT = R(LS-1)
      EPS = RØØT * 3.E-7
      K = LØW
      DØ 200  I = 1,KØUNT
      RØØT = AMIN1(RØØT-EPS,R(K))
      CALL  QWIEL(RØØT,X(1,I))
  200 K = K + 1
      RETURN
      END
```

```
C ..... RØUTINE ** TFØRM  ** ABACUS UPDATED 05/20/72 .....
      SUBRØUTINE TFØRM(A,N,D,Ø,S,P)
      DIMENSIØN A(1),D(1),Ø(1),S(1)
      BL = 0.
      BU = 0.
      ØLD = 0.
      D(1) = A(1)
      K1K1 = 1
      N1 = N - 1
      DØ 230  K = 1,N1
      KP1 = K + 1
      KK = K1K1
      KKP1 = KK + 1
      NK = N - K
      KN = KK + NK
      K1K1 = KN + 1
      SUM = 0.
      DØ 100  KJ = KKP1,KN
  100 SUM = SUM + A(KJ)*A(KJ)
      S(K) = SUM
      RHØ = SQRT(SUM)
      RAD = ØLD + RHØ
      BL = AMIN1(BL,D(K)-RAD)
      BU = AMAX1(BU,D(K)+RAD)
      IF (K - N1) 120,230,230
  120 ØLD = RHØ
      IF (A(KKP1)) 140,140,130
  130 RHØ = -RHØ
  140 Ø(K) = RHØ
      IF (SUM) 150,230,150
  150 A(KKP1) = A(KKP1) - RHØ
      RHØ =  1. / (RHØ*A(KKP1))
      A(KK) = RHØ
      IJ = KK
      DØ 160  J = KP1,N
      IJ = IJ + 1
      Ø(J) = A(IJ)
  160 D(J) = 0.
      II = K1K1
      NI = NK
      DØ 190  I = KP1,N
      D(I) = D(I) + A(II)*Ø(I)
      IJ = II
      II = II + NI
      NI = NI - 1
      IF (NI) 170,190,170
  170 X = Ø(I)
      DØ 180  J = I,N1
      IJ = IJ + 1
      D(J+1) = D(J+1) + A(IJ)*X
  180 D(I) = D(I) + A(IJ)*Ø(J+1)
  190 D(I) = D(I) * RHØ
      SUM = 0.
      DØ 200  I = KP1,N
  200 SUM = SUM + D(I)*Ø(I)
      TAU = RHØ * SUM * .5
      DØ 210  I = KP1,N
  210 D(I) = D(I) + TAU*Ø(I)
      II = K1K1
      NI = NK
```

```
      DØ 220  I = KP1,N                                                 3900600
      RHØ = D(I)                                                        3900610
      TAU = Ø(I)                                                        3900620
      IJ = II                                                           3900630
      II = II + NI                                                      3900640
      NI = NI - 1                                                       3900650
      DØ 220  J = I,N                                                   3900660
      A(IJ) = A(IJ) + RHØ*Ø(J) + TAU*D(J)                               3900670
  220 IJ = IJ + 1                                                       3900680
  230 D(K+1) = A(KIKI)                                                  3900690
      Ø(N1) = A(KKP1)                                                   3900700
      Ø(N) = AMIN1(BL,D(N)-RHØ)                                         3900710
      S(N) = AMAX1(BU,D(N)+RHØ)                                         3900720
      RETURN                                                            3900730
      END                                                               3900740
```

```
C ..... RØUTINE ** STURM  ** ABACUS UPDATED 05/20/72 .....            4000000
      SUBRØUTINE STURM (N,LIM1,NUMB,D,ØFFD,SEC,PFFD,SIGMA,EPS)         4000010
      DIMENSIØN D(1),ØFFD(1),SEC(1),SIGMA(1),PFFD(1)                   4000020
      DATA HALF / .5/                                                  4000030
      BL = ØFFD(N)                                                     4000040
      BU = SEC(N)                                                      4000050
      LIM2 = LIM1 + NUMB - 1                                           4000060
      CALL PREP (N,D,SEC,RØØT,LØRD)
      N1 = N - 1                                                       4000080
      IF (N1) 16,200,200                                               4000090
  200 TØL = AMAX1(-BL,BU)                                              4000100
      ØFFD(N) = TØL                                                    4000110
      TØL = TØL * AMAX1(1.E-15,EPS)                                    4000120
      DØ 2  I = LIM1,LIM2                                              4000130
      SIGMA(I) = BL                                                    4000140
    2 PFFD(I) = BU                                                     4000150
      LØRD = 0                                                         4000160
      L = LIM1 - 1                                                     4000170
      RUTE = 1.E20                                                     4000180
      GØ TØ 3                                                          4000190
  300 DØ 400  I = K,L                                                  4000200
  400 SIGMA(I) = RØØT                                                  4000210
    3 K = L + 1                                                        4000220
      IF (K - LIM2) 4,4,16                                             4000230
    4 BU = PFFD(K)                                                     4000240
      RØØT = BU  +  HALF * (SIGMA(K) - BU)                             4000250
      IF (K - L) 5,7,5                                                 4000260
    5 DØ 6  I = K,LIM2                                                 4000270
      IF (BU - PFFD(I)) 7,6,7                                          4000280
    6 L = I                                                            4000290
    7 IF (ABS(RØØT - RUTE) - TØL) 300,300,8                            4000300
    8 CALL DET (N,D,SEC,RØØT,LØRD)
      DØ 11  I = K,L                                                   4000320
      IF(I -LØRD) 9,9,10                                               4000330
    9 SIGMA(I) = RØØT                                                  4000340
      GØ TØ 11                                                         4000350
   10 PFFD(I) = RØØT                                                   4000360
   11 CØNTINUE                                                         4000370
      RUTE = RØØT                                                      4000380
      GØ TØ 4                                                          4000390
   16 RETURN                                                           4000400
      END                                                              4000410
```

```
END ØF FILE
C ..... RØUTINE **  PREP  ** ABACUS UPDATED 05/20/72 .....         4100000
      SUBRØUTINE PREP (N,D,SEC,RØØT,LØRD)
      DIMENSIØN D(1),SEC(1)                                         4100020
      EQUIVALENCE (RD2,RE2),(RD4,RE4)                               4100030
      N1 = N - 1                                                    4100040
      GØ TØ 200                                                     4100050
      ENTRY DET (N,D,SEC,RØØT,LØRD)
      RDO = RØØT                                                    4100070
      LØW = 0                                                       4100080
      LAWD = 0                                                      4100090
  100 RD2 = 0.D0                                                    4100100
      RD4 = 1.D0                                                    4100110
      DØ 120  I = LØW,N1                                            4100120
      RD4 = D(I+1) - RDO - RD2                                      4100130
      IF (RD4) 120,140,110                                          4100140
  110 LAWD = LAWD + 1                                               4100150
  120 RE2 = SEC(I+1) / RE4                                          4100160
  130 LØRD = LAWD                                                   4100170
      GØ TØ 200                                                     4100180
  140 LAWD = LAWD + 1                                               4100190
      IF (RE2) 150,160,150                                          4100200
  150 I = I + 1                                                     4100210
  160 LØW = I + 1                                                   4100220
      IF (LØW - N1) 100,100,130                                     4100230
  200 RETURN                                                        4100240
      END                                                           4100250
```

```
C ..... RØUTINE ** QSVEC  ** ABACUS UPDATED 05/20/72 .....
      SUBRØUTINE  QSVEC(A,D,ØFFD,P,Q,R,S,N)
C  SYMMETRIC MATRIX EIGENVECTØR CALCULATIØN.
C  GIVEN THE ENTRIES (D AND ØFFD) ØF THE HØUSEHØLDER TRI-DIAGØNAL FØRM B
C     ØF A REAL SYMMETRIC MATRIX A, AND GIVEN A GØØD APPRØXIMATE RØØT ØF
C     B (AND A) THIS FØRTRAN 4 SUBRØUTINE CØMPUTES A UNIT EIGENVECTØR X
C     ØF B, THEN TRANSFØRMS IT TØ A UNIT VECTØR ØF A, USING THE VECTØRS W
C     STØRED IN THE A ARRAY.
      DIMENSIØN A(1),D(1),ØFFD(1),P(1),Q(1),R(1),S(1),X(1)
      DØUBLE PRECISIØN SUM
      CØMMØN /INFØ/ SUM,M,IX,IA
      DATA FLAG/0777777777776/
C
C  PART 1.  PRELIMINARIES.
C
      IX = 1
      IA = 1
      N1 = N - 1
      N2 = N - 2
      RETURN
      ENTRY  QWIEL(RØØT,X)
      ASSIGN 170 TØ KØUNT
      TØL = 0.
      DØ 100  I = 1,N
      P(I) = D(I) - RØØT
      Q(I) = ØFFD(I)
      R(I) = 0.
      TØL = AMAX1(TØL,ABS(D(I)))
      CALL RANDØM (XX)
  100 X(I) = XX+.1
      TØL = (TØL + 1.E-15) * 1.E-15
C
C  PART 2.  MATRIX DECØMPØSITIØN.
C
      DØ 150  I = 1,N1
      T = ABS (P(I))
      U = ABS (ØFFD(I))
      IF (T + U - TØL) 110,120,120
  110 P(I) = TØL
      T = P(I)
  120 IF (T - U) 130,140,140
  130 S(I) = P(I)/ØFFD(I)
      CALL ANDD (S(I),1,S(I),1)
      TEMP = Q(I)
      P(I) = ØFFD(I)
      Q(I) = P(I+1)
      R(I) = Q(I+1)
      P(I+1) = TEMP - S(I)*Q(I)
      Q(I+1) = -S(I)*R(I)
      GØ TØ 150
  140 S(I) = ØFFD(I)/P(I)
      CALL ANDD (S(I),FLAG,S(I),0)
      P(I+1) = P(I+1) - S(I)*Q(I)
  150 CØNTINUE
      IF (ABS(P(N)) .LT. TØL)  P(N) = TØL
      GØ TØ 210
C
C  PART 3.  RIGHT SIDE MØDIFICATIØN.
C
  170 ASSIGN 330 TØ KØUNT
```

```
      DØ 200  I = 1,NI                                               4200580
      CALL ANDD (S(I),1,TEMP,0)
      IF (TEMP) 180,190,180                                          4200600
  180 T = X(I)                                                       4200610
      X(I) = X(I+1)                                                  4200620
      X(I+1) = T - S(I)*X(I)                                         4200630
      GØ TØ 200                                                      4200640
  190 X(I+1) = X(I+1) - S(I)*X(I)                                    4200650
  200 CØNTINUE                                                       4200660
C                                                                    4200670
C  PART 4.  TRIANGULAR SYSTEM SØLUTIØN.                              4200680
C                                                                    4200690
  210 X(N) = X(N)/P(N)                                               4200700
      X(N1) = (X(N1) - Q(N1)*X(N)) / P(N1)                           4200710
      DØ 220  I = 2,NI                                               4200720
      K = N - I                                                      4200730
  220 X(K) = (X(K) - Q(K)*X(K+1) - R(K)*X(K+2)) / P(K)               4200740
C                                                                    4200750
C  PART 5. SCALING TØ UNIT VECTØR.                                   4200760
C                                                                    4200770
  230 SUM = 0.D0                                                     4200780
      M = N                                                          4200790
      CALL DØTPRØ (X,X)                                              4200791
      SCALAR = DSQRT(SUM)                                            4200800
      DØ 250  I = 1,N                                                4200810
  250 X(I) = X(I)/SCALAR                                             4200820
      GØ TØ KØUNT, (170,330,370)                                     4200830
C                                                                    4200840
C  PART 6.  TRANSFØRMATIØN BY ØRTHØGØNAL MATRICES.                   4200850
C                                                                    4200860
  330 L = (N*(N+1))/2 - 4                                            4200870
      DØ 360  I = 1,N2                                               4200880
      NI = N - I                                                     4200890
      SUM = 0.D0                                                     4200900
      M = I + 1                                                      4200910
      CALL DØTPRØ (X(NI),A(L))                                       4200911
      SCALAR = A(L-1)*SUM                                            4200920
      IJ = L                                                         4200930
      DØ 350 J=NI,N                                                  4200940
      X(J) = X(J) + SCALAR*A(IJ)                                     4200950
  350 IJ = IJ + 1                                                    4200960
  360 L = L - I - 3                                                  4200970
      ASSIGN 370 TØ KØUNT                                            4200980
      GØ TØ 230                                                      4200990
  370 RETURN                                                         4201000
      END                                                            4201010
```

```
      SUBRØUTINE ANDD (X,Y,Z,IFLAG)
      LØGICAL UND,JA,NEIN
      REAL NØ
      EQUIVALENCE (UND,E),(JA,SI),(NEIN,NØ)
    1 SI = X
      NØ = Y
      UND = JA.AND.NEIN
      IF (IFLAG.EQ.1) UND = JA.ØR.NEIN
      Z = E
      RETURN
      END
```

```
C ..... RØUTINE ** DØTPRØ ** ABACUS UPDATED 05/20/72 .....
      SUBRØUTINE DØTPRØ (X,Y)
      DIMENSIØN X(1),Y(1)
      DØUBLE PRECISIØN S
      CØMMØN /INFØ/ S,N,IX,IY
      IF (N) 120,120,100
  100 JX = 1
      JY = 1
      DØ 110  J = 1,N
      S = S + X(JX)*Y(JY)
      JX = JX + IX
  110 JY = JY + IY
  120 RETURN
      END
```

SUBROUTINE DETERM

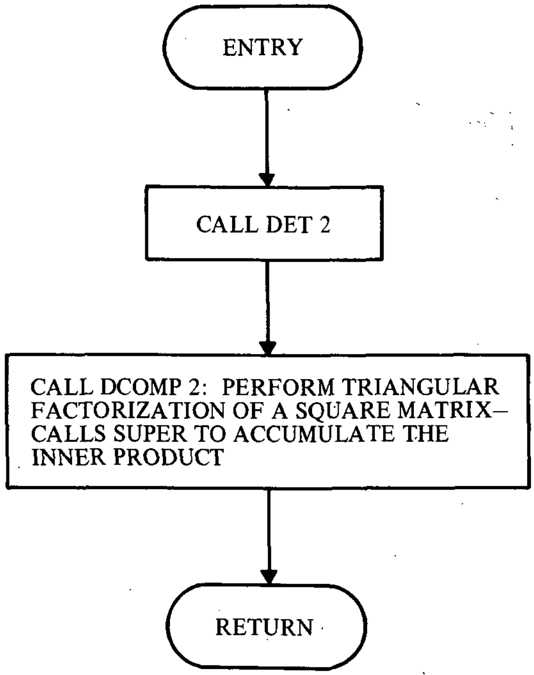
This is the controlling routine for the program determinant evaluation loop. The matrix in question is passed to DET2 where the determinant evaluation calculations occur.

Subroutine DET2: This routine computes the determinant of a square matrix. The actual determinant value is normalized to ±1.

Subroutine DCOMP2: This routine performs the triangular factorization of a square matrix.

Subroutine SUPER: This routine performs inner product accumulation.

DETERM


ENTRY
CALL DET 2
CALL DCOMP 2: PERFORM TRIANGULAR FACTORIZATION OF A SQUARE MATRIX–CALLS SUPER TO ACCUMULATE THE INNER PRODUCT
RETURN

```
      SUBRØUTINE DETERM (NZ,MDET)
      DIMENSIØN A(128,128),T(256)
      REWIND 4
      DØ 187 I=1,NZ
  187 READ(4) (A(I,J),J=1,NZ)
      CALL DET2 (A,NZ,128,T,NU,D)
      WRITE(6,80) D
   80 FØRMAT(///20X,-DETERMINANT =-,F5.1)
      MDET = D
      REWIND 4
      RETURN
      END
```

```
      SUBRØUTINE DET2 (A, M, MID, T, NU, D)
C
C      DETERMINANT ØF A SPARSE IN-CØRE REAL MATRIX, WITH PRØTECTIØN
C      AGAINST ØVERFLØW AND UNDERFLØW.  DETERMINANT IS GIVEN IN A
C      SPECIAL FØRM TØ ALLØW REPRESENTATIØN ØF VERY LARGE ØR SMALL
C      VALUES.
C
C     WITH
C
C        A      -  FØRTRAN DØUBLE ARRAY CØNTAINING THE MATRIX.
C
C        M      -  ØRDER ØF MATRIX A, I.E. ACTUAL NUMBER ØF RØWS.
C
C        MID    -  FIRST DIMENSIØN ØF ARRAY A, I.E. MAX. NØ. ØF RØWS.
C
C        T      -  WØRKING STØRAGE ARRAY ØF AT LEAST 2*M REAL NØS.
C
C        NU, D  -  DETERMINANT IS GIVEN AS (16**NU) * D.
C
C
      DIMENSIØN A(1), T(1)
      EQUIVALENCE (P,IP)
      CALL DCØMP2 (A, M, MID, T, T(M+1), NIX)
      NU = 0
      IF (NIX) 100,110,120
  100 D = 0.
      GØ TØ 999
  110 D = 1.
      GØ TØ 130
  120 D = -1.
  130 MID1 = MID + 1
      MMID = M * MID
      DØ 140  II = 1,MMID,MID1
      IF (A(II)) 150,140,140
  150 D = -D
  140 CØNTINUE
  999 CØNTINUE
      RETURN
      END
```

```
      SUBRØUTINE DCØMP2(A,M,MID,LEAD,ENT,NIX)
      INTEGER*2 LEAD
C       TRIANGULAR DECØMPØSITIØN ØF A SPARSE IN-CØRE MATRIX.
      DØUBLE PRECISIØN S
      DIMENSIØN A(1), LEAD(1), ENT(1)
      DATA MØNE / -1 /
      EQUIVALENCE (EL,L)
      NIX = 0
      EPS = 1.E-6
      MP1 = M + 1
      MMID = M * MID
      MM = MMID + M - MID
      DØ 130  I = 1,M
      DØ 100  IJ = I,MM,MID
      IF (A(IJ)) 110,100,110
  100 CØNTINUE
C       IF LØØP FALLS THRØUGH, RØW I IS ZERØ AND A IS SINGULAR.
      NIX = -(1000 + I)
      GØ TØ 999
  110 LEAD(I) = (IJ - I) / MID  +  1
C       LEAD(I) IS THE CØLUMN INDEX ØF 1ST NØN-ZERØ ENTRY ØF RØW I.
      G = 0.
      DØ 120  KJ = IJ,MM,MID
  120 G = ABS( A(KJ) )  +  G
  130 ENT(I) = 16. / G
      KB = 1
      MK = M
      LAST = 0
      KK = 1
C
C       MAJØR LØØP.  CØLUMN K ØF A IS USED TØ PRØDUCE CØLUMN K ØF L AND
C       U.  ABØVE DIAGØNAL, A ELEMENTS CØNVERT TØ U ELEMENTS,  AFTER
C       PIVØT SELECTIØN (USING PARTIAL PIVØTING WITH IMPLICIT RØW
C       SCALING), THE U(K,K) AND L(I,K) ELEMENTS ARE CØMPUTED.  AN
C       ATTEMPT  IS MADE TØ SUPPRESS TRIVIAL ØPERATIØNS BY SKIPPING THE
C       LEADING ZERØ TERMS IN EACH INNER PRØDUCT.  SUPER DØES THE INNER
C       PRØDUCT ACCUMULATIØN AND IS AVAILABLE IN FØRTRAN AND (360)
C       ASSEMBLY LANGUAGE.
C
      DØ 310 K=1,M
      DØ 140  JK = KB,MK
      IF (A(JK)) 150,140,150
  140 CØNTINUE
C       IF LØØP FALLS THRØUGH, CØLUMN K IS ZERØ AND A IS SINGULAR.
      GØ TØ 998
  150 LØWK = JK
      LØW = JK - KB + 1
      JK = MK
      DØ 160  J = 1,M
      IF (A(JK)) 170,160,170
  160 JK = JK + MØNE
C       LØØP CAN-T FALL THRØUGH.
  170 LAST = MAX0(LAST,MP1-J)
      LASTK = KB + LAST - 1
C       FIRST K CØLUMNS CØNTAIN ALL ZERØS BELØW RØW LAST.
      IK =LØWK
      LIMIT = 0
      G = 0.
      DØ 180  I = LØW,LAST
      G = AMAX1(G, ENT(I)*ABS(A(IK)))
```

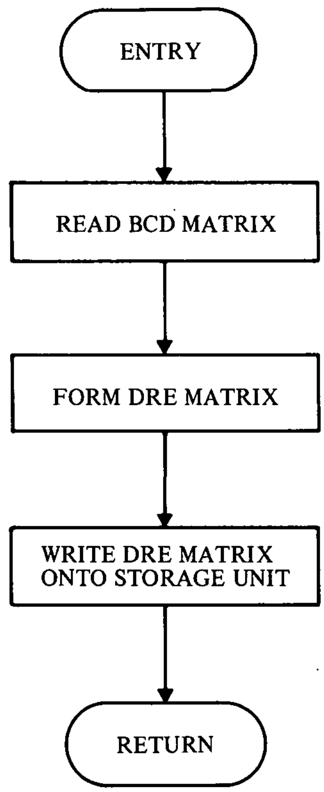
```
180 IK = IK + 1
    TØL = G * EPS
    IK =LØWK
    TØP = 0.
    DØ 230  I = LØW,LAST
    LEAST = LEAD(I)
    LEAST = MAX0(LEAST,LØW)
    CALL SUPER (A(I),A(KB),LEAST,LIMIT,MID,S)
    A(IK) = S+A(IK)
    IF(I - K) 200,210,210
200 LIMIT = I
    GØ TØ 230
210 G = ABS(A(IK)) * ENT(I)
    IF (TØP - G) 220,230,230
220 TØP = G
    L = I
230 IK = IK + 1
    IF (TØP - TØL) 998,240,240
240 G = ENT(L)
    ENT(L) = ENT(K)
    ENT(K) = G
    IF (L - K) 250,270,250
250 LEED = LEAD(K)
    KLEED = LEAD(L)
    LEED = MIN0(LEED,KLEED)
    KLEED = (LEED - 1) * MID  +  K
    LJ = KLEED + L - K
    DØ 260  KJ = KLEED,MM,MID
    TØP = A(KJ)
    A(KJ) = A(LJ)
    A(LJ) = TØP
260 LJ = LJ + MID
    J = LEAD(L)
    LEAD(L) = LEAD(K)
    LEAD(K) = J
    NIX = 1 - NIX
270 KK1 = KK + 1
    LEAD(M+K) = L
    IF (KK1 - LASTK) 280,280,300
280 G = -A(KK)
    DØ 290  IK = KK1,LASTK
290 A(IK) = A(IK) / G
300 KB = KB + MID
    MK = MK + MID
310 KK = KB + K
    GØ TØ 999
998 NIX = -K
999 RETURN
    END
```

```
      SUBROUTINE SUPER (X,Y,LEAST,LIMIT,MID,S)
      DIMENSIØN X(1), Y(1)
      DØUBLE PRECISIØN S
      S = 0.0D0
      IF (LEAST - LIMIT) 100,100,120
  100 IX = (LEAST - 1) * MID  +  1
      DØ 110  I = LEAST,LIMIT
      S = S + X(IX)*Y(I)
  110 IX = IX + MID
  120 RETURN
      END
```

SUBROUTINE BCVECT

This routine converts the eigenvector obtained during a converged eigenvalue pass into the form accepted by INITAL. The calculations are identical to those in the latter part of STRMAT, and result in the DRE array.

BCVECT


ENTRY
READ BCD MATRIX
FORM DRE MATRIX
WRITE DRE MATRIX ONTO STORAGE UNIT
RETURN

```
C ..... RØUTINE ** BCVECT ** ABACUS UPDATED 07/24/72 .....               4600000
      SUBRØUTINE BCVECT (NZ,QVEC,NØJS,JRTIC,JRSTØP,NREG)                 4600010
      DIMENSIØN QVEC(128,1),BCD(128,128),JRTIC(1),JRSTØP(1),DRE(128,2)
      REWIND 3                                                           4600030
      REWIND 14                                                          4600040
      NJTNH4 = 4*NØJS                                                    4600050
      READ(14) ((BCD(I,J),J=1,NZ),I=1,NJTNH4)                            4600060
      DØ 800 L=1,2
      DØ 800 J=1,NJTNH4                                                  4600070
      DRE(J,L)=0.
      DØ 800 K=1,NZ                                                      4600090
  800 DRE(J,L)=DRE(J,L)+BCD(J,K)*QVEC(K,L)
      DØ 71 NR=1,NREG                                                    4600110
      DØ 71 K=1,2                                                        4600120
      II = (JRTIC(NR)-1)*4+1                                             4600130
      IF (K.EQ.2) II = JRSTØP(NR)*4-3                                    4600140
      III = II+3                                                         4600150
      DØ 71 I=II,III                                                     4600160
   71 WRITE(3)(DRE(I,L),L=1,2)
      REWIND 3                                                           4600180
      RETURN                                                             4600190
      END                                                                4600200
```

This is an error trap routine which can be called by the MAIN routine at various stages of program execution. If the indicator NIX is not equal to zero, MAIN will call ETRAP and indicate the proper message to be printed.

```
C ..... RØUTINE **D22      ** ABACUS UPDATED 07/07/72 .....               2300000
      SUBRØUTINE ETRAP                                                    2300010
      INTEGER SAVJTC,SAVSTP,Q,THICK
      INTEGER XN                                                          2300030
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)           2300040
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)                              2300050
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(2),NH             2300060
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)    2300070
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB   2300080
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE   2300090
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS              2300100
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK
      WRITE(6,1726)
 1726 FØRMAT(1H1)
      GØ TØ (8000,8036,8086,8087,8089,8090,8013,8009,8031,8008,8001,
     1       8002,8003,8006,8007,8067,8101,8102,8103,8104,8105,8106,
     2       8107,8108,8109,8110,8088,110,8120,8841,8842,8777,8797,
     3       8787),NERRØR
 8000 WRITE(6,1)
    1 FØRMAT(/  4X,-ØNE ØF THE MATERIAL PRØPERTY TABLES CANNØT BE IDENTI
     1FIED AS ISØT, ØRTH, ØR STIF.-/)
      GØ TØ 505
 8036 WRITE(6,2)
    2 FØRMAT(/  4X,-A MATERIAL PRØPERTY TABLE NAME FØR A SEGMENT CANNØT
     1BE FØUND IN THE TABLE LIST.-/)
      GØ TØ 505
 8086 WRITE(6,3)
    3 FØRMAT(/  4X,-THE TYPE ØF GEØMETRY ØF A SEGMENT CANNØT BE IDENTIFI
     1ED AS ØNE HANDLED BY THE PRØGRAM.-/)
      GØ TØ 505
 8087 WRITE(6,4)
    4 FØRMAT(/  4X,-THE TYPE ØF MATERIAL PRØPERTY TABLE FØR A SEGMENT CA
     1NNØT BE IDENTIFIED AS ISØT, ØRTH, ØR STIF.-/)
      GØ TØ 505
 8089 WRITE(6,5)
    5 FØRMAT(/  4X,-THE WALL CØNSTRUCTIØN ØF A SEGMENT CANNØT BE IDENTIF
     1IED AS SING, EQUA, UNEQ, ØR BLAN.-/)
      GØ TØ 505
 8090 WRITE(6,6)
    6 FØRMAT(/  4X,-THE TYPE ØF TEMPERATURE INPUT FØR A SEGMENT CANNØT B
     1E IDENTIFIED AS THST, NØTH, THCN, ØR THIN.-/)
 8013 GØ TØ 505
 8009 GØ TØ 505
 8031 WRITE(6,9)
    9 FØRMAT(/  4X,-THE LØAD INDICATØR CLUES CAN ØNLY BE ZERØ, BLANK, ØN
     1E, ØR FØUR.-/)
      GØ TØ 505
 8008 WRITE(6,10)
   10 FØRMAT(/  4X,-THE PRØGRAM CAN EXECUTE ØNLY ØNE THERMAL LØAD PRØBLE
     1M PER DATA DECK.-/)
      GØ TØ 505
 8001 WRITE(6,11)
   11 FØRMAT(/  4X,-THE MAGIC CYCLE HAS GØNE PAST STØP BY MØRE THAN THE
     1PERMITTED VALUE. CHECK TØ SEE IF FIXED STEP SIZE IS TØØ LARGE.-/)
      GØ TØ 505
 8002 WRITE(6,12)
   12 FØRMAT(/  4X,-THE RIEMAN VARIABLE, IEND, WHICH SIGNALS THE END ØF
     1A SEGMENT SHØULD ØNLY BE ZERØ ØR NEGATIVE ØNE.-/)
 8003 GØ TØ 505
 8006 GØ TØ 505
```

```
8007 WRITE(6,15)
  15 FØRMAT(/  4X,-THE INTERPØLATED VALUE ØF TEMPERATURE FØR THE MATERI
    1AL PRØPERTY TABLE IS LESS THAN THE SECØND TEMPERATURE VALUE.-/)
     GØ TØ 505
8067 WRITE(6,16)
  16 FØRMAT(/  4X,-THE INTERPØLATED VALUE ØF TEMPERATURE FØR THE MATERI
    1AL PRØPERTY TABLE IS GREATER THAN THE LAST VALUE ØF TEMPERATURE.-
    2/)
     GØ TØ 505
8101 WRITE(6,17)
  17 FØRMAT(/  4X,-THE K11 STIFFNESS PARAMETER IS ZERØ.-/)
     GØ TØ 505
8102 WRITE(6,18)
  18 FØRMAT(/  4X,-THE K12 STIFFNESS PARAMETER IS ZERØ.-/)
     GØ TØ 505
8103 WRITE(6,19)
  19 FØRMAT(/  4X,-THE K21 STIFFNESS PARAMETER IS ZERØ.-/)
     GØ TØ 505
8104 WRITE(6,20)
  20 FØRMAT(/  4X,-THE K22 STIFFNESS PARAMETER IS ZERØ.-/)
     GØ TØ 505
8105 WRITE(6,21)
  21 FØRMAT(/  4X,-THE K33 STIFFNESS PARAMETER IS ZERØ.-/)
     GØ TØ 505
8106 WRITE(6,22)
  22 FØRMAT(/  4X,-THE D11 STIFFNESS PARAMETER IS ZERØ.-/)
     GØ TØ 505
8107 WRITE(6,23)
  23 FØRMAT(/  4X,-THE D12 STIFFNESS PARAMETER IS ZERØ.-/)
     GØ TØ 505
8108 WRITE(6,24)
  24 FØRMAT(/  4X,-THE D21 STIFFNESS PARAMETER IS ZERØ.-/)
     GØ TØ 505
8109 WRITE(6,25)
  25 FØRMAT(/  4X,-THE D22 STIFFNESS PARAMETER IS ZERØ.-/)
     GØ TØ 505
8110 WRITE(6,26)
  26 FØRMAT(/  4X,-THE D33 STIFFNESS PARAMETER IS ZERØ.-/)
     GØ TØ 505
8088 WRITE(6,27)
  27 FØRMAT(/  4X,-THE PRØGRAM CANNØT DETERMINE WHETHER THE PRØBLEM INP
    1UT IS THIC, RWAF, RWA1, RWA2, RWA3, ST10, ST11, ST12, ST13, ISG1,
    2ISG2, ØR ISG3.-/)
 110 GØ TØ 505
8120 WRITE(6,29)
  29 FØRMAT(/  4X,-THE Y2 BLØCK IN THE SEGMENT MAGIC ØUTPUT IS SINGULAR
    1.-/)
     GØ TØ 505
8841 WRITE(6,30)
  30 FØRMAT(/  4X,-IN THE CØMPUTATIØN ØF THE REGIØN STIFFNESSES, THE K2
    12 MATRIX WAS NØT PØSITIVE DEFINITE.-/)
     GØ TØ 505
8842 WRITE(6,31)
  31 FØRMAT(/  4X,-IN THE CØMPUTATIØN ØF THE REGIØN LØADS, THE K22 MATR
    1IX WAS NØT PØSITIVE DEFINITE.-/)
     GØ TØ 505
8777 WRITE(6,32)
  32 FØRMAT(/  4X,-IN THE CØMPUTATIØN ØF THE REDUCED FLEXIBILITY MATRIX
    1, THE REDUCED STIFFNESS MATRIX IS SINGULAR.-/)
     GØ TØ 505
8797 WRITE(6,33)
```

```
   33 FØRMAT(/  4X,-FØR KINEMATIC LINKS BETWEEN SEGMENTS, THE DEPENDENT
     1JØINT NUMBER MUST BE GREATER THAN THE INDEPENDENT JØINT NUMBER.-/)
      GØ TØ 505
 8787 WRITE(6,34)
   34 FØRMAT(/  4X,-THE NUMBER ØF PØINTS IN THE ST TABLE MUST BE BETWEEN
     1 2 AND 30.-/)
  505 RETURN
      END
```

REFERENCES

1. Svalbonas, V., "Numerical Analysis of Stiffened Shells of Revolution - Vol. I: Theory", NASA CR-2273.

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